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FM 6-150

WAR DEPARTMENT FIELD MANUAL

ORGANIC FIELD ARTILLERY AIR OBSERVATION

WAR DEPARTMENT • 30 AUGUST 1944

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FM 6-150

ORGANIC
FIELD ARTILLERY
AIR OBSERVATION



WAR DEPARTMENT

● *30 AUGUST 1944*

United States Government Printing Office
Washington : 1944

WAR DEPARTMENT,
WASHINGTON 25, D. C., 30 AUGUST 1944.

FM 6-150, Organic Field Artillery Air Observation,
is published for the information and guidance of all
concerned.

[A.G. 300.7 (7 July 44).]

BY ORDER OF THE SECRETARY OF WAR:

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Chief of Staff.

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For explanation of symbols, see FM 21-6.

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CHAPTER 1

GENERAL

1. ROLE.

a. The primary mission of organic field artillery air observation is to supplement ground observation by:

- (1) Locating appropriate targets.
- (2) Adjusting artillery fire.

b. Secondary missions include:

(1) Reconnaissance of position areas and march routes.

(2) Security patrols.

(3) Camouflage checks.

(4) Obtaining information of friendly and nearby hostile forces. (Reconnaissance flights should not be conducted over enemy territory where dangerous ground fire may be expected.)

(5) Maintaining liaison for control of march columns.

2. SCOPE. This manual describes the training, tactical employment, administration, maintenance, and supply of organic field artillery air observation. It is intended to meet the needs of commanders of air observation personnel.

3. TERMS.

a. Air OP. The liaison aircraft of a unit together with the personnel assigned to operate and maintain them are designated as the "air OP."

b. Landing strip. A narrow piece of land suitable for the landing and take-off of aircraft.

c. Landing field. A landing strip complete with installations necessary for the operation of the air OP is designated as a "landing field."

d. Pilot. In this manual, a field artillery liaison pilot is referred to as a "pilot."

e. Unit commander. In this manual, the term "unit commander" designates the commander of a field artillery unit which has a headquarters and headquarters battery, such as a battalion, group, or higher field artillery echelon. When other unit commanders are specified, they will be designated by the title of the unit, such as headquarters battery commander.

4. ORGANIZATION.

a. General. Air OP personnel are assigned to the headquarters battery of each field artillery battalion (with the exception of observation battalions); headquarters, field artillery group; headquarters, field artillery brigade; headquarters, infantry division artillery; headquarters, armored division artillery; headquarters, light division artillery; headquarters, cavalry division artillery; and headquarters, corps artillery.

b. Artillery air officer.

(1) *General.* An artillery air officer is included on the special staff of the commander of army artillery, corps artillery, field artillery brigade, division artillery, and field artillery group. He should be a highly qualified field artilleryman. In addition, he will hold a currently valid liaison pilot rating, be physically qualified for flying duty, and be required to participate regularly and frequently in aerial flights. He has no command function. The corps artillery air officer, as an assistant to the corps artillery commander, carries out such inspections of air observation installations and training within the corps, including subordinate divisions, as are directed by the corps commander.

(2) *Duties.* The artillery air officer will be prepared to assist the commander and staff by:

(a) Advising on all matters pertaining to organic air observation.

(b) Inspecting for compliance with applicable regulations and directives concerning air traffic, the operation of aircraft, and the maintenance of flight records; the maintenance and repair of aircraft, and prescribed forms and records.

(c) Preparing, coordinating, and supervising plans for training air observation personnel.

(d) Acting as a coordinating agency to insure rapid procurement and distribution of aircraft supplies, parts, and equipment.

c. Senior battalion pilot. In addition to his duties as observer and pilot, the senior battalion pilot functions as artillery air officer on the staff of the battalion commander. He will be prepared to assist the battalion commander in those staff functions outlined in b (2) above which are applicable to battalions.

d. Duties of key personnel. Principal duties of key personnel of the air OP are to:

INDIVIDUAL

DUTIES

Pilot	Operate aircraft and supervise their maintenance; act as observer for firing, reconnaissance, and other air missions; complete necessary forms and records; select and supervise landing strips.
-------------	--

(Senior) Mechanic,
army airplane and
engine

Perform airplane maintenance and repair; prepare and maintain landing strips; assist in completing necessary forms and records. In group and division artillery, the senior mechanic assists the artillery air officer in technical inspections and is charged with the care of spare parts.

Mechanic, army airplane and engine...

Assist the senior mechanic.

5. EQUIPMENT.

a. General. The equipment of the air OP is shown in appropriate tables of equipment. In general, it consists of two liaison-type airplanes, special equipment pertaining thereto, radio communication equipment, transportation, and a caliber .50 machine gun provided for the defense of the landing field. Equipment needed for training, not specifically listed in tables of equipment, must be improvised.

b. Performance of liaison-type aircraft.

(1) Based on practical performance tests, the L-4 airplane is considered superior to the L-2 and L-3, for the purposes intended. The L-5 is superior to the L-4 in the following respects: Take-off performance, especially at high altitudes; rate of climb; and ease of handling under high wind conditions.

(2) A landing field of approximately 300 yards without excessively high barriers will normally accommodate the operation of all present types of liaison airplanes. Under full load the L-2 will require 75 percent more take-off distance than the L-4, while the L-3 will require 40 percent more than the L-4.

(3) Other essential characteristics are as follows:

	L-2	L-3	L-4	L-5
Weight of plane (lbs.)	824	727	740	1472.5
Carrying capacity including fuel and accessories (lbs.)	478	430	430	662.5
Power (h.p.)	65	65	65	183
Cruising time (hrs.)	2.5	2.5	2.5	3
Cruising speed (m.p.h.)	75	75	70	105
Landing speed (m.p.h.)	40	38	38	50
Fuel capacity (gals.)	14	14	12	36
Maximum safe operating headwinds (m.p.h.)	25-30	25-30	25-30	35-40
Maximum safe operating crosswinds (m.p.h.)	15-20	15-20	15-20	20-25

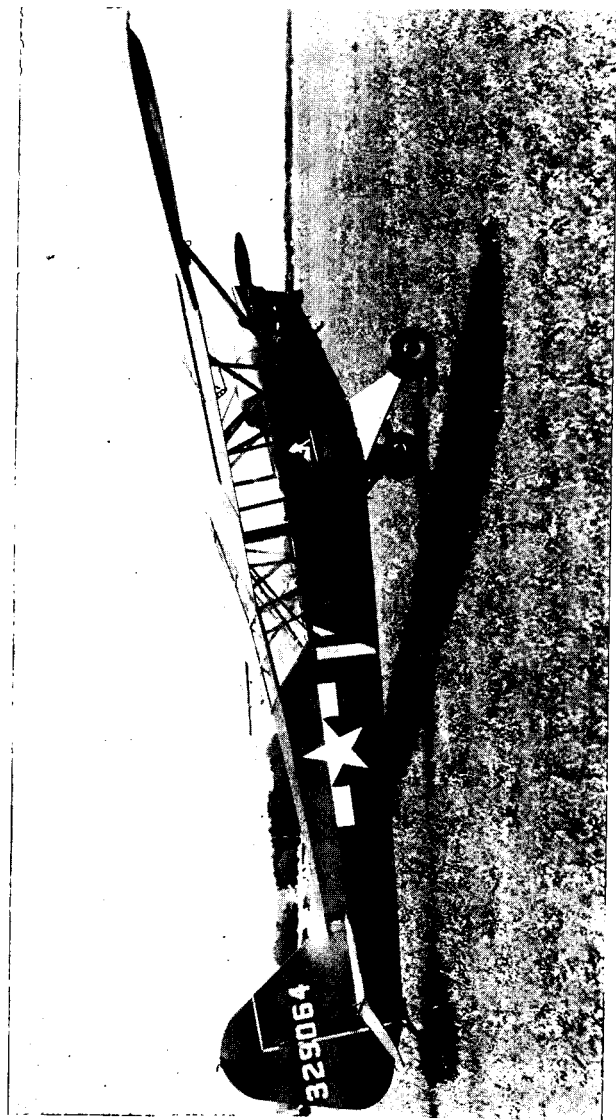


FIGURE 1. Field artillery liaison airplane (L-4H, standard type).

6. AIR TRAFFIC REGULATIONS. The control of air traffic on the landing field is the responsibility of the field artillery commander to whom the field is assigned. Except under tactical or simulated tactical conditions, all extended flights will be conducted in accordance with Army Air Forces Regulations 60-16. In addition, the field artillery commander will publish and enforce such local air traffic and field regulations as are necessary to prevent careless or hazardous flights. An example of instructions which might be included in such local regulations is included in appendix I.

CHAPTER 2

TRAINING, GENERAL

7. RESPONSIBILITY FOR TRAINING. The unit commander is responsible for the proper training of air observation personnel and that adequate first and second echelons of maintenance for the aircraft and equipment are properly performed. Individuals assigned to air observation should be examined promptly to determine the type and amount of training each will require to complete both the basic training program of the unit and the individual and tactical training programs of the air OP. Since there will usually be a wide variance in the previous training and experience of new personnel, the training program of the air OP must be flexible and progressive.

8. SCOPE OF TRAINING.

a. Enlisted and officer personnel of the air OP should be thoroughly trained as field artillerymen prior to, or concurrent with, specialized training in air observation.

b. Programs for specialized training of air observation personnel should distinguish between *individual* and *tactical* training. In this manual:

(1) Training of air observation personnel as members of the air OP team is termed *individual training*.

(2) Inclusion of the air OP in the tactical exercises or field problems of the organic unit is termed *tactical training*.

9. CONDUCT OF TRAINING.

a. Individual and tactical training should progress concurrently. Tactical training should be conducted under the direct control of the battalion commander;

it should parallel the tactical training of the unit. All training of air observation personnel should be guided by the doctrine that in combat the air OP functions as an integral part of its organic unit. To the fullest extent possible, therefore, training should be conducted by battalions.

b. Because of limited landing areas, lack of qualified instructors or adequate equipment, it may be necessary and desirable to centralize the individual training under the group or division field artillery commander. Such centralization should not preclude the return of air observation personnel to their respective units for concurrent tactical training.

c. When the individual training of air observation personnel is centralized under group, division artillery, or higher commander to take advantage of highly qualified instructors, the commander centralizing the individual training should also assume responsibility for the application and examination phases of such training.

d. The tactical training should be conducted by unit commanders concurrently with other training or should be conducted as soon after completion of individual training as practicable.

10. INSPECTIONS. Division artillery commanders, artillery group commanders, and commanders of larger units should keep themselves informed as to the state of maintenance and progress of training of air OPs in their units. To this end, frequent inspections should be made by their artillery air officers. A guide for such inspections is inclosed as appendix II.

CHAPTER 3

INDIVIDUAL TRAINING

11. GENERAL. Individual training includes:

- a. Ground handling.
- b. Communication.
- c. Flight training.
- d. Observer training.
- e. Maintenance.

12. SELECTION OF LANDING FIELDS FOR INDIVIDUAL TRAINING. A landing field selected for individual training should be:

a. Located outside the traffic pattern of any field from which high-performance aircraft operate. See figure 2.

b. Large enough to permit fully loaded airplanes to take off under conditions of high temperature and no wind.

13. GROUND HANDLING. To prevent injury to personnel and damage to the airplane, the ground crew must be instructed in proper methods of ground handling.

a. Pushing and turning the airplane. The only parts of the airplane to which pressure may be applied in pushing and turning are:

- (1) Struts, at either end.
- (2) Propeller hub (caution should be exercised because an engine, hot from recent operation, sometimes will "kick" due to preignition).
- (3) Wing bow tips. In the vicinity of obstructions, a member of the ground crew should be at each wing tip; he should be capable of correctly estimating clearances.
- (4) Tail lift handle should always be used in lifting the tail or turning the airplane by hand.

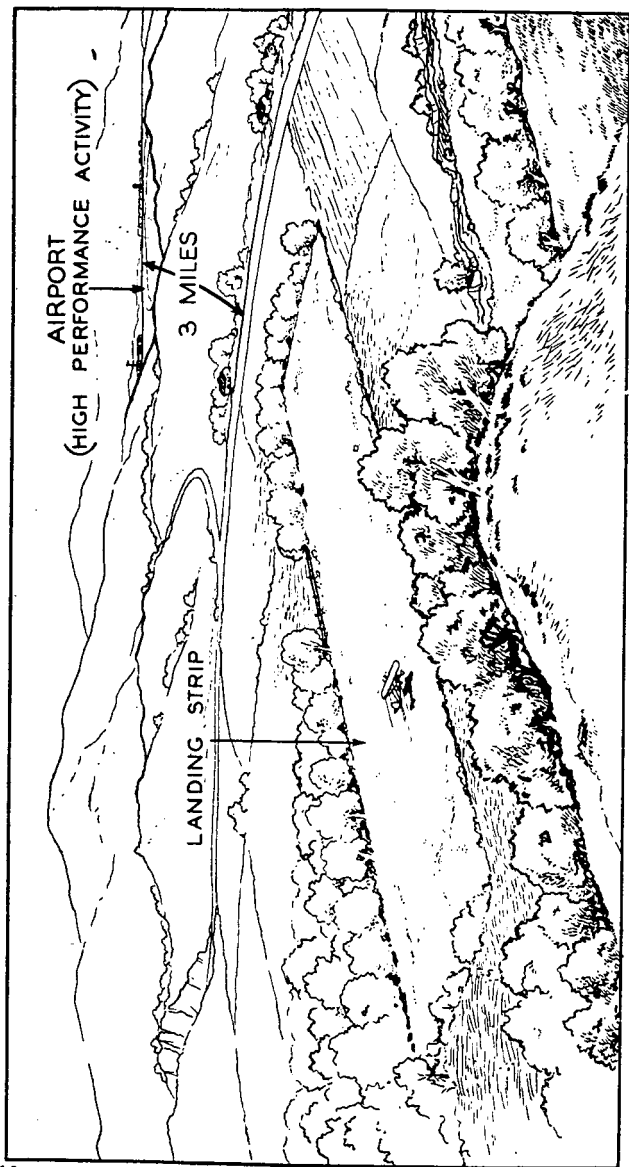


FIGURE 2. Example of location of a landing strip.

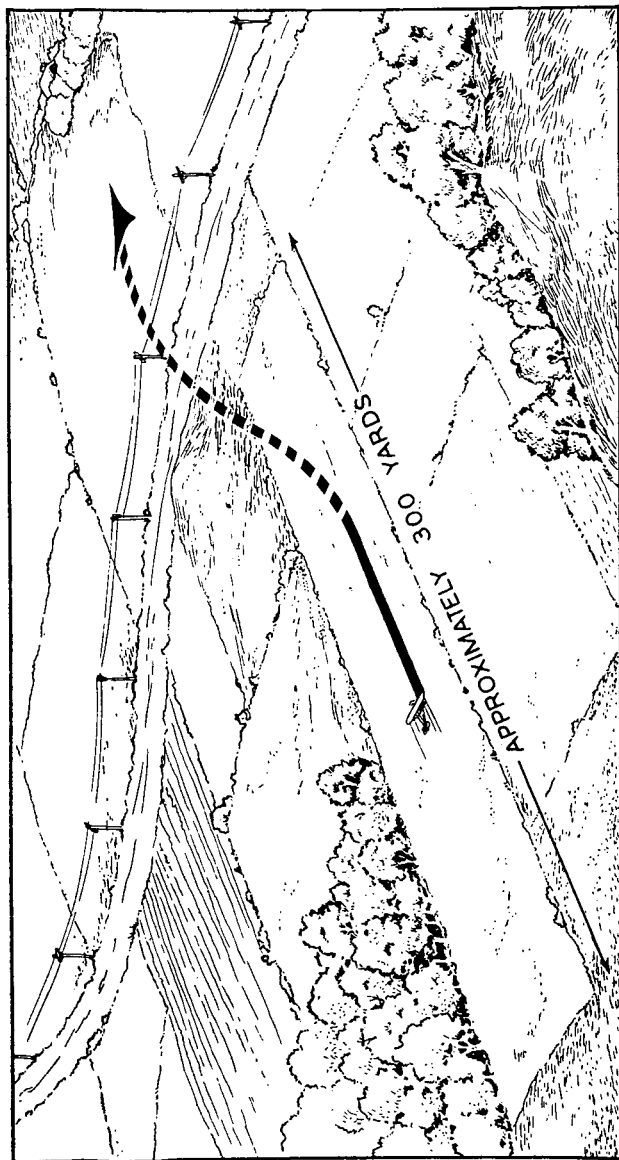


FIGURE 3. Length of landing strip.

b. Tie-downs. The airplane should never be left unattended unless tied down. The purpose of a tie-down is to secure aircraft from high winds. See figure 4 for illustration of proper tie-down.

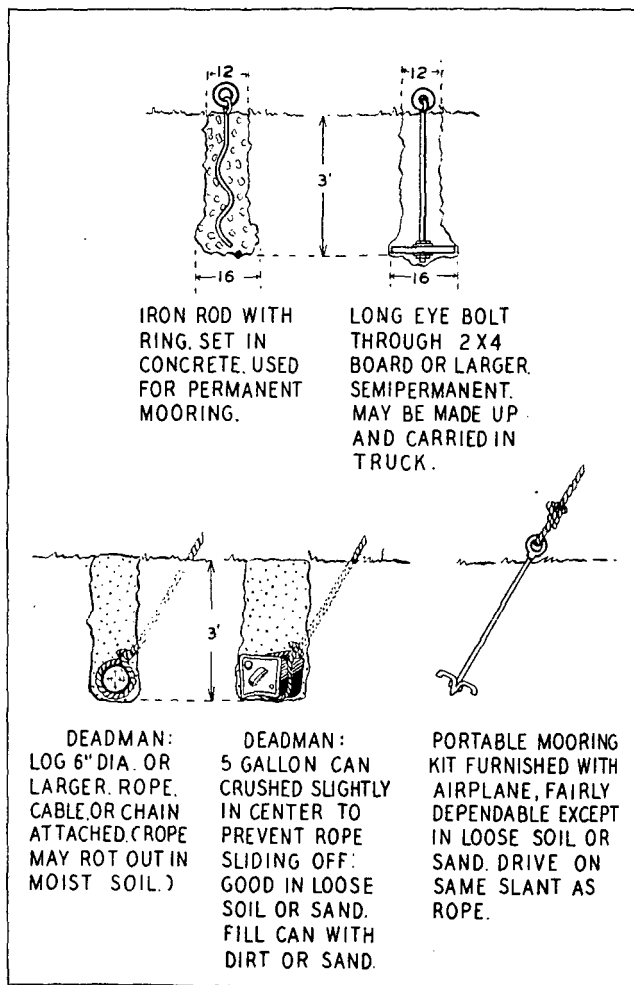


FIGURE 4. Types of tie-downs.

c. Control locks. See figure 5.

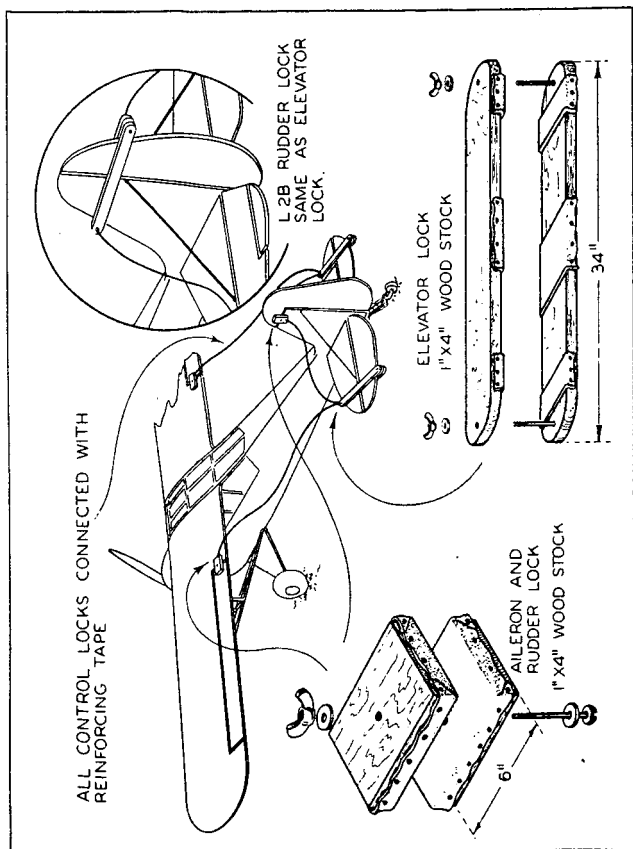


FIGURE 5. Control locks.

d. High wind precautions. Units should make arrangements with higher headquarters to provide advance information of any forecasted high winds. To secure aircraft against unusually high winds, the following precautions may be taken:

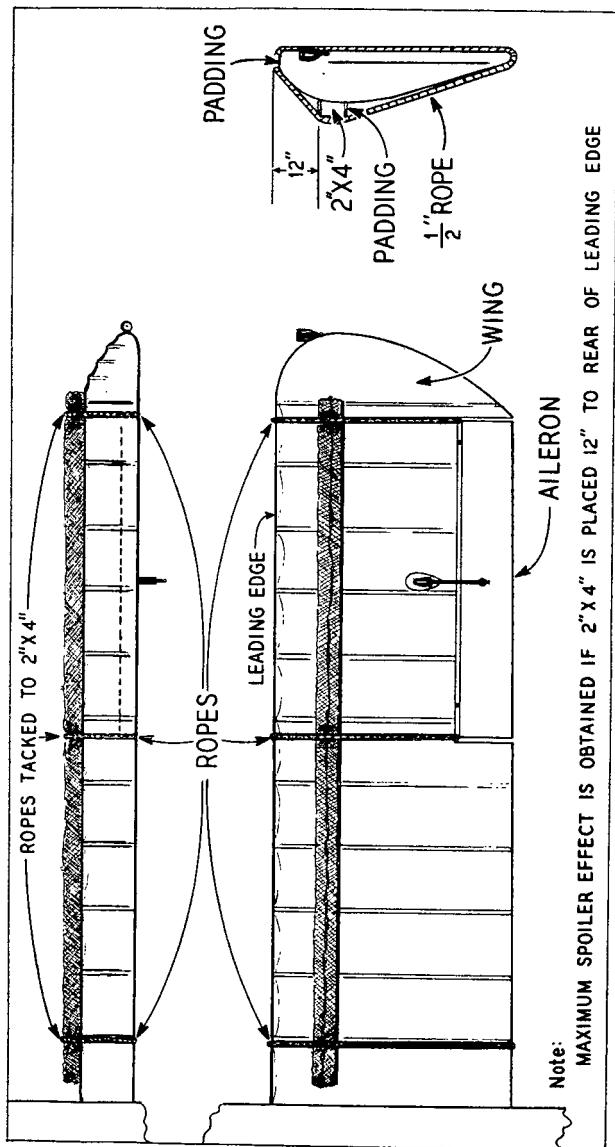


FIGURE 6. Use of the spoiler.

(1) To lessen the angle of attack and reduce the lift effect of the wind, head the airplane into the wind, with the wheels dug in and the tail raised approximately to the level-flight position. Unless proper drainage can be established, wheel pits should be no deeper than 8 inches, to prevent accumulated water from entering the brake mechanism of the wheels.

(2) Block out the force of the wind by placing a truck or sandbags on the windward side of the airplane.

(3) The lift effect obtained by wind moving past the wings may be minimized by the application of a set of "spoilers." Spoilers are pieces of lumber, 2" x 4" x 12', padded with burlap, canvas, or similar material, and tied with ropes to the upper surface of each wing along the front spar.

e. Refueling.

(1) Before the airplane is refueled, electrical bonding should be effected (fig. 7).

(2) Fuel should be strained through a chamois whenever possible.

(3) Fuel cans should not be left partially full overnight but should be refilled to prevent condensation. If excess water is known to be in gasoline cans, the last half-gallon in each can should not be used.

f. Starting engine. All members of the ground crew should be trained to start the engine using correct procedure. Wheel chocks should be applied before the engine is started. (See app. I, par. 2f.)

g. Taxiing. All members of the ground crew should be trained to taxi the airplane.

14. COMMUNICATION. All personnel of the air OP must be thoroughly trained in the following means of communication:

a. Radio. Since radio is the normal means of air-ground communication, training should include:

(1) Radiotelephone procedure as covered in FM 24-9.

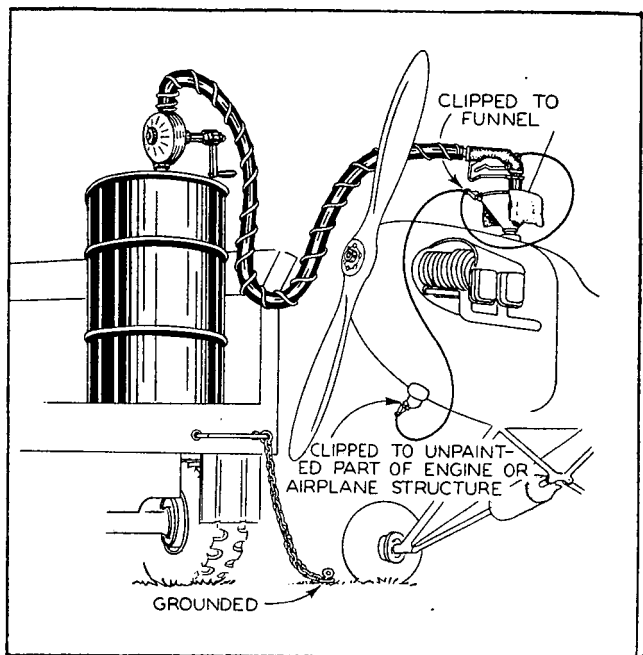


FIGURE 7. Electrical bonding.

(2) Installation and operation of the radio to be used in the liaison airplane. (See app. V.)

(3) Operation of all types of radios that may be used as base sets at the landing field.

(4) Frequent practice by the air OP with the fire-direction center to develop teamwork.

b. Wire. Wherever practicable, a telephone line is installed between the battalion command post and the landing field. All air observation personnel should be competent to install, maintain, and operate telephone communication.

c. Visual signals. Units should be trained in the following system of visual signals, to be used between the airplane and the ground in the event of a radio fail-

ure while fire missions are being conducted. Air OP personnel, individuals detailed as observers, and key firing battery personnel should be familiar with the system.

AIRPLANE SIGNALS

<i>Signal</i>	<i>Meaning</i>
Zoom 100	Over (repeated for each 100 yards).
Dive 100	Short (repeated for each 100 yards).
Dipping right wing . 100	Right (repeated for each 100 yards).
Dipping left wing . 100	Left (repeated for each 100 yards).
Fishtail	Repeat range.
Tight circle	Fire for effect.
Peel off to right . . .	Cease firing or mission accomplished.

GROUND SIGNALS

<i>Panel Signal</i>	<i>Meaning</i>
(Removal of panel)	Battery has fired.
	Roger, wait; or battery is ready.
	Repeat message.
	Mission accomplished, go home.
	Danger; enemy aircraft.

NOTE: Standard issue panels are used for these signals.

d. Drop message and pick-up message station.

When radio cannot be used, a drop message and pick-up message system is valuable for the transmission of single messages.

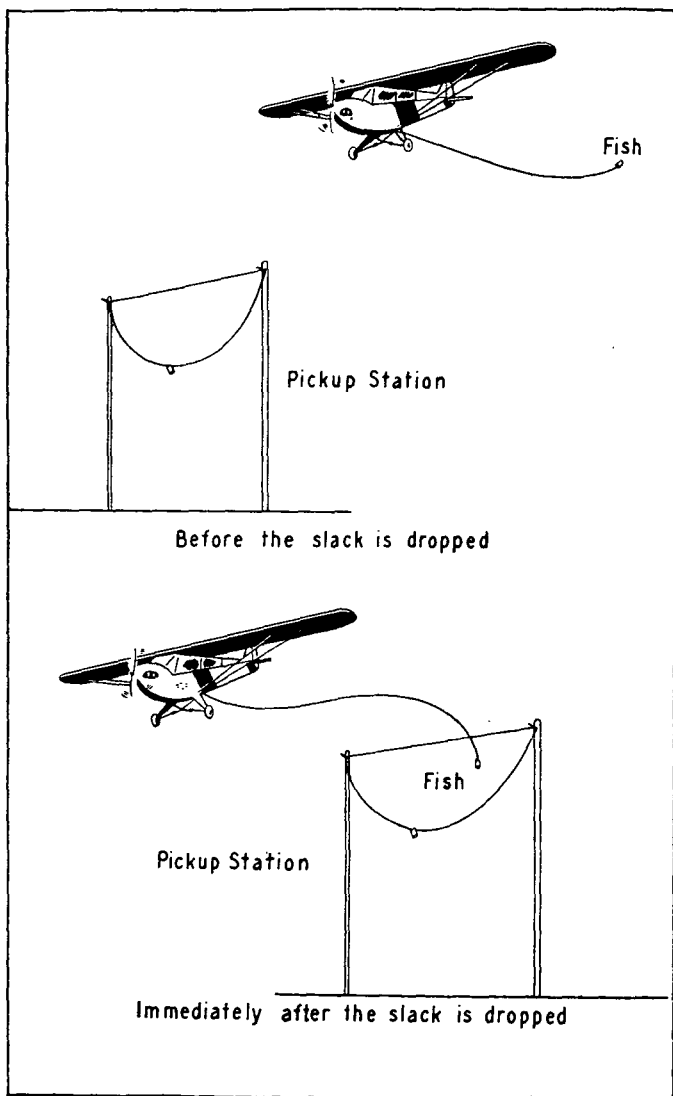


FIGURE 8. Pick-up station, message bag suspended from poles.

(1) Air OP and message center personnel should be familiar with the operation of the system as outlined in FM 24-5. For reasons of safety, the grapnel weight will not be used on the pick-up line. Any weight of a pound or two will suffice as a substitute.

(2) An approved method requiring less equipment is shown in figure 9.

(a) The ground station is operated by two men. The message is attached to a long cord which has a small sandbag at each end. The two men throw the message line up so that it is caught by the airplane pick-up line.

(b) The crew on the ground can adjust their position to the flight path of the airplane, greatly simplifying the procedure for the pilot. The station can be operated in some uncleared areas where the ground crew can toss the message cord above the height of trees and other obstructions.

(c) This system will be used only with light, low-speed aircraft.

15. FLIGHT TRAINING. (For detailed flight maneuvers, see appendix III.) Pilots must be prepared to fly in combat under varying conditions of weather, terrain, and movement. To insure the necessary high standard of flying proficiency, pilot training should be continuous and progressive; it should include:

a. Ground school. Pilots must be thoroughly familiar with the following subjects and references:

(1) Navigation. Before making extended flights, pilots should know the pertinent material covered in FM 1-30 and TM 1-205.

(2) Meteorology. Since he will usually be his own weather forecaster, the pilot must have a working knowledge of appropriate sections of TM 1-230.

(3) Pilot's Information File. The pilot should know applicable information in his Pilot's Information File (published by the Army Air Forces).

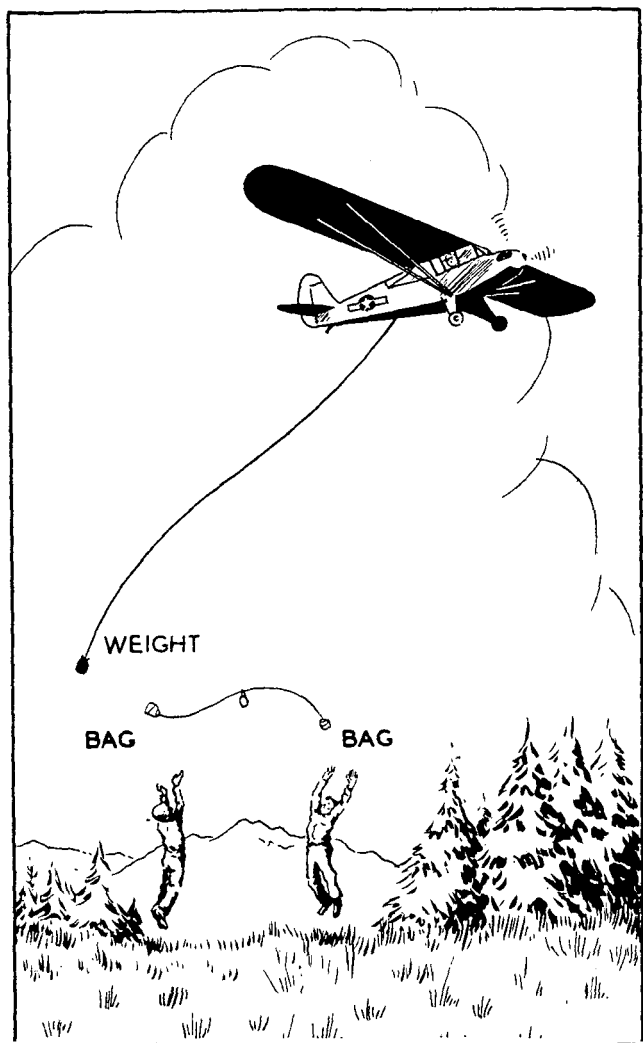


FIGURE 9. Pick-up station, message bag tossed up by two men.

b. Basic flight maneuvers (TM 1-210). Pilots must be expert at:

- (1) Take-offs and landings.
- (2) Coordination exercises.
- (3) Level turns.
- (4) S-turns.
- (5) Rectangular courses.
- (6) Eights around pylons.
- (7) Climbing and diving turns.
- (8) Slips.
- (9) Two-turn power-off spins.
- (10) Lazy eights.
- (11) Chandelles.

c. Special flight maneuvers.

- (1) Take-offs and landings to panels.
- (2) Take-offs and landings over barriers.
- (3) Take-offs and landings on roads.
- (4) Crosswind landings and take-offs.
- (5) One-wheel landings and take-offs.
- (6) Contour flying (when specifically authorized and in specified areas only).
- (7) Landings from contour approaches.
- (8) Evasive maneuvers.

d. Extended flights. The unit commander should designate the local flying area, and report its location in accordance with AR 95-15. Any flights outside this area are extended flights. Tactical operations require long and short extended flights.

(1) Scope of training. Extended flights should begin with short trips to air bases at which the traffic is not too heavy. As pilots become more proficient, they should make long flights at normal altitudes above 500 feet. Finally they should make low-level extended flights to qualify them for the long, low-level displacement flights necessary in combat. Each pilot should make from two to four extended flights each month.

(2) Requirements. Extended flights should be governed by the following conditions:

(a) They should be made only when specifically authorized by unit commanders.

(b) They should be authorized only when the pilot:

1. Is thoroughly familiar with Army Air Forces Regulations 60-16.

2. Is familiar with Army Air Forces Forms 15, 17, and 23.

3. Has demonstrated a knowledge of ground school subjects, covered in *a* above.

4. Has submitted a complete flight plan. (See appendix III for suggested form of flight plan.)

5. Has a knowledge of control tower light signals.

(c) Except in cases of emergency, pilots should land only on fields under the jurisdiction of the Army of the United States or on established civil airfields.

(d) If the pilot remains away from his home field overnight, he will notify his unit commander by telegraph or telephone.

e. Night flights. The usefulness of the air OP in combat is greatly increased if it is capable of performing night operations. See paragraph 30.

(1) Night flying involves the following additional hazards:

(a) Take-offs and landings are more difficult to accomplish because the ground and obstructions are less visible.

(b) The pilot is subject to momentary blindness from bright lights.

(c) There is more danger of becoming lost.

(d) Collision with other aircraft is more likely.

(e) It is sometimes necessary for the pilot to resort to short periods of instrument flying due to unforeseen conditions of poor visibility and light.

(2) Training in night flying should begin only when the following conditions can be met:

(a) The *pilot* must have had sufficient previous experience in night flying and must be reasonably proficient in basic instrument flying using rate instruments.

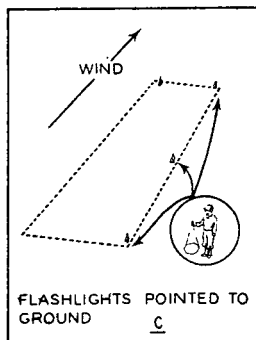
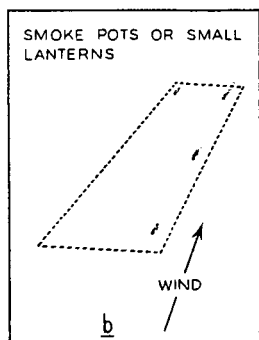
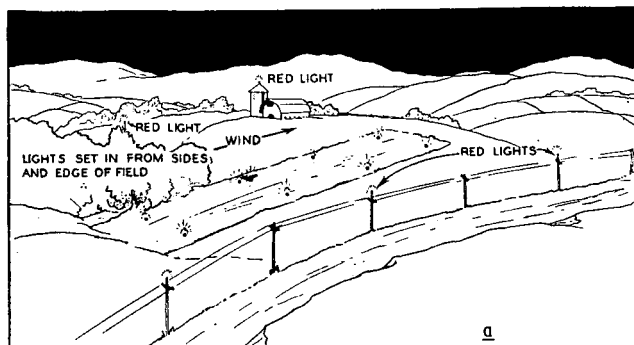


FIGURE 10. Lighting of training field and boundaries for night flying.

(b) The *airplane* must be equipped with proper position lights, luminous or illuminated instruments, and a bank and turn indicator.

(c) The *training field* should be approximately twice the size of that required for day flights. It should have clear approaches; boundaries and high obstructions in the vicinity should be adequately marked with lights.

(3) *Scope of training.* Training in night flying should begin with elementary flight maneuvers such as take-offs, landings, and gentle turns at dusk and on moon-light nights when illumination from half-moon or

better is available, and visibility and ceiling conditions are above contact minimum. This training should progress to darker nights as ability and proficiency of the pilot increase. The pilot should continue training until qualified to make simulated combat flights at night.

16. OBSERVER TRAINING. The success of the air OP depends principally on the proficiency of the air observer.

a. Personnel to be trained as air observers. The pilot must be a trained observer; often he may have to fly missions alone. In addition, as many selected officers and enlisted men as available should be trained for this duty. Those selected for training should weigh less than 170 pounds (stripped). If practicable, one or two officers should be detailed as principal air observers.

b. Training phases. The training of the air observer may be divided into two phases and conducted concurrently.

(1) *Ground training* should include:

(a) Nomenclature, characteristics, and functioning of the airplane.

(b) Ground handling, cockpit procedure, and safety precautions.

(c) Conduct of fire; daily use of the terrain board with emphasis on forward observation methods.

(d) Advanced training in the use of maps and air photos.

(e) Friendly and enemy tactics and materiel, to enable ready recognition and facilitate analysis of what is seen from the air.

(f) Radio operation and procedure.

(2) *Air training* should include:

(a) Orientation to accustom the observer to the airplane in flight and to preserving his sense of direction. He should practice estimating ground distances and altitudes from the air.

(b) Simulated fire missions and frequent use of a puff target range (app. VI).

(c) Fire missions during service practice. Even when he is not firing the problem, the observer can gain knowledge and facility by watching from the air the conduct of fire by both ground and air observers. When radio is used, the air observer can hear all traffic in the net; when telephone is used, the sensings of the ground observer should be relayed to the air observer by radio.

(d) Local and extended flights which will give him practice in performing the air OP missions enumerated in paragraph 1.

(e) Comparison of terrain features with maps and air photos of the area.

(f) Team training with the pilot. Because of engine noise, conversation in the cockpit is carried on with difficulty. Pilot and observer must be able to anticipate each other's needs and problems in the air. *Example:* During a fire mission, the pilot must know when to turn so as to avoid blocking the observer's view as the burst appears.

(g) Frequent flights from the "enemy" side of the impact area to study movements, positions, materiel, and gun flashes of the unit during its field exercises.

17. MAINTENANCE TRAINING.

a. Pilot. Since the senior pilot is charged with the supervision of maintenance and repair of the airplanes, his training must insure that he is qualified to:

(1) Direct the first and second echelon maintenance.

(2) Perform the required inspections to determine serviceability of airplane and engine.

(3) Analyze mechanical failures.

(4) Accomplish emergency repairs in the event of a forced landing.

b. Senior mechanic, airplane and engine. Senior mechanics should be thoroughly trained and qualified to effect:

- (1) Inspections:
 - (a) Prescribed routine visual inspections.
 - (b) Parachute inspections.
 - (c) Compass compensation.
- (2) First and second echelon repairs.
- (3) Erection of crated aircraft.
- (4) Preparation of aircraft for shipment according to Army Air Forces Technical Orders 00-25-8, 00-25-8A, 01-1-7, 01-1-31, 01-1-31E, and 02-1-1. (See also app. IV.)
- (5) Loading aircraft on vehicles. (See app. IV.)

c. Junior mechanic, airplane and engine. By working with the senior mechanic, the junior mechanic must acquire both technical knowledge and skill. His training should be progressive and should include:

- (1) Nomenclature, characteristics, and functioning.
- (2) Ground handling.
- (3) Inspections.
- (4) Maintenance records.
- (5) Repairs.

CHAPTER 4

TACTICAL TRAINING AND EMPLOYMENT

18. GENERAL.

a. The most significant characteristic of liaison-type aircraft is their capacity for operation over long periods of time, with a small quantity of fuel and supplies, away from any fixed installation. It is this characteristic which permits their employment as organic aviation by field artillery.

b. Altitudes of flight missions. To minimize the risk of detection and attack by hostile ground and air forces, the air OP should fly at the lowest altitude consistent with the success of each mission.

c. Tactical training includes:

- (1) Reconnaissance, selection, improvement, and operation of landing fields.
- (2) Security measures.
- (3) Displacements.
- (4) Locating targets.
- (5) Adjusting artillery fire.
- (6) Reconnaissance of position areas and march routes.
- (7) March control.
- (8) Patrol.
- (9) Camouflage checks.
- (10) Obtaining information of friendly and hostile forces by flying over friendly areas.

19. STAFF RELATIONS. Each staff section should be familiar with the needs, the capabilities, and the types of employment of the air OP. All staff members should

be capable of selecting suitable landing fields during ground reconnaissance.

a. S-2.

(1) Prior to the mission, the S-2 should familiarize both the pilot and observer with the current situation, friendly and enemy.

(2) On the completion of a mission, the S-2 should always question the pilot and observer for information of friendly and enemy forces.

b. S-3.

(1) To reduce the time of the flight mission, the S-3 should brief both pilot and observer with all information necessary for the accomplishment of the mission. The maximum prearrangement of fires between the S-3 and the air OP will also help reduce the duration of flight missions.

(2) During unavoidable delays in firing, the S-3 should permit the pilot to land.

(3) In order to fully understand and best utilize the air OP, the S-3 should function as air observer on occasion.

(4) At the completion of the mission, the S-3 should question the pilot and observer concerning the effect of the fire and for any other information pertinent to firing or the firing chart.

c. Headquarters battery commander. In order to provide proper replacements and additional help when needed, the commander of headquarters battery should be familiar with the duties of air observation personnel. He should facilitate the functioning of air observation personnel as a team.

20. RECONNAISSANCE, SELECTION, IMPROVEMENT, AND OPERATION OF LANDING FIELDS.

a. Reconnaissance. Observers, selected personnel in headquarters and service batteries, and air observation personnel must be competent to make thorough and speedy reconnaissance for landing fields to insure avail-

ability of the air OP for missions immediately following the displacement of the unit. Before the actual ground reconnaissance, personnel should make a map or photo reconnaissance. Overlapping air photos provide valuable information of possible landing areas. Depending upon the allotted time, reconnaissance for landing fields can be accomplished by one of these general methods:

(1) *Air-and-ground*. When sufficient time is available, this method should always be used: The pilot and mechanic (or observer) reconnoiter by air for several suitable strips within the assigned area. Having thus automatically eliminated any which cannot be readily approached from the air, they repeat the reconnaissance on the ground, selecting the most advantageous of the previously located strips.

(2) *Ground*. When sufficient time for an air-and-ground reconnaissance is lacking, the pilot, accompanied by the observer or a member of the ground crew, proceeds by vehicle or on foot to the assigned area, selecting a strip most suitable for organization as a landing field. The ground reconnaissance may be made by other trained personnel in conjunction with the reconnaissance for battery or battalion positions.

(3) *Air*. Only as a last resort, when time cannot be obtained for air-and-ground or ground reconnaissance, the air reconnaissance may be used. In an extremely fast-moving situation, it may be necessary for the pilot and observer to fly forward, select a strip from the air, and land on it. Since isolated mines, rocks, and small holes can seldom be seen from the air, attempting to land without prior ground reconnaissance is a dangerous practice.

b. Selection. Observers, selected personnel in headquarters and service batteries, and air observation personnel must be competent to select suitable landing fields.

(1) A suitable landing field *must* meet the following conditions:

(a) Provide a strip or clearing adequate for take-off. This strip must be:

1. Sufficiently long. Temperature, altitude, slope of the ground, and wind will cause the necessary length to vary.

2. Comparatively smooth.

3. Capable of approach. The strip will have to provide additional length, to permit clearance under all weather conditions, if barriers hinder take-off or landing. If the strip is completely walled in, dead or turbulent air may result, greatly increasing the hazards of the take-off and landing.

4. Selected with consideration to the direction of the prevailing wind. Strong crosswinds present a hazard.

(b) Clear of mines. In sodded or cultivated areas, the pattern of a mine field may be detected from the air. Air observation personnel must be prepared to locate and remove mines from landing strips.

(c) Drainage must be adequate. The airplane cannot operate from flooded or extremely muddy areas.

(2) A suitable landing field should meet, *as far as possible*, the following conditions:

(a) Conveniently located with respect to the battalion command post. It is desirable that the distance be less than a mile but it will vary with terrain and the availability of landing strips.

(b) Natural camouflage for aircraft and installations.

(c) Space for dispersion of aircraft and installations.

(d) Defilade from enemy ground observation.

c. Improvement. Immediately after the field has been selected, its improvement should begin: It must be made ready for immediate use; detection by the enemy should be made difficult.

(1) *Development of the strip.* Before aircraft are displaced to a new field, the strip should be:

(a) Cleared of mines and booby traps.

(b) Pioneered. Within limits dictated by considerations of flying safety, pioneer work should be restricted

to a minimum to avoid making the strip obvious. Rocks, trees, heavy underbrush, and other obstacles should be removed and all holes and ruts filled. If the strip is dangerously wet or muddy, it may have to be graveled.

(c) Concealed. As illustrated in figure 11, vehicular tracks may be used to extend the outline of the strip, beyond its usable limits, into a road or group of trees. The strip, thus extended, appears from the air to be a road or trail.

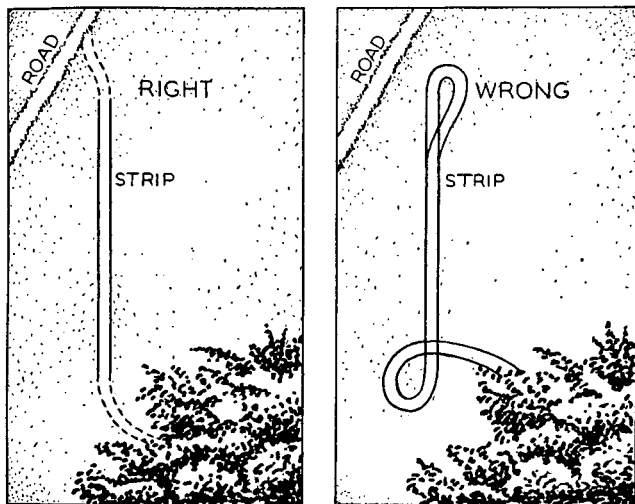


FIGURE 11. Concealment of landing strips.

(2) *Camouflage of installations.* Before the equipment of the air OP is brought to the new field, a complete plan of camouflage should be drawn up. This plan should take advantage of natural camouflage and dispersal area. The principles of camouflage and camouflage discipline set down in FM 5-20 should be closely adhered to.

(a) *Airplane camouflage.* A distance of 200 yards or more should be kept between airplanes. This distance should increase as natural camouflage decreases. Dis-

tinctive insignia of the airplane, pyralin, and shiny surfaces should be covered.

(b) *Vehicle camouflage.* Vehicles should be dispersed and camouflaged in a location convenient to a road.

(3) *Other security measures.*

(a) Automatic weapons should be set up for protection against enemy aircraft.

(b) Alternate fields, if available, should be improved so that the air OP may be readily displaced, preferably to the rear of the main field, in the event of persistent shelling or aerial attack by the enemy.

(c) Dummy fields, if cleverly organized, may deceive the enemy and divert much of his fire.

(4) *Supply route.* If an existing route of supply cannot be used, a new one must be organized, careful consideration being given its concealment.

(5) *Communication.* Initially, radio communication is established. As soon as time permits, wire is installed to the command post or to a convenient switching central.

d. Operation. The following principles govern generally the operation of a tactical landing field:

(1) *Landing.* When the airplane approaches, the ground crew should be prepared to mark the landing strip and to assist the pilot in taxiing the airplane to cover.

(a) There are two accepted methods of marking the strip:

1. The first few times a new strip is used, a "T" panel is placed at the downwind end to indicate direction of landing, wind direction, and one end of the strip. A single panel is placed at the upwind end to mark the other end of the strip. Panels should be displayed only on prearranged signal; they should be removed as soon as the airplane has landed.

2. After a few landings have been made, the ground crew may dispense with the panel system; two men can guide the pilot onto the strip (fig. 13).

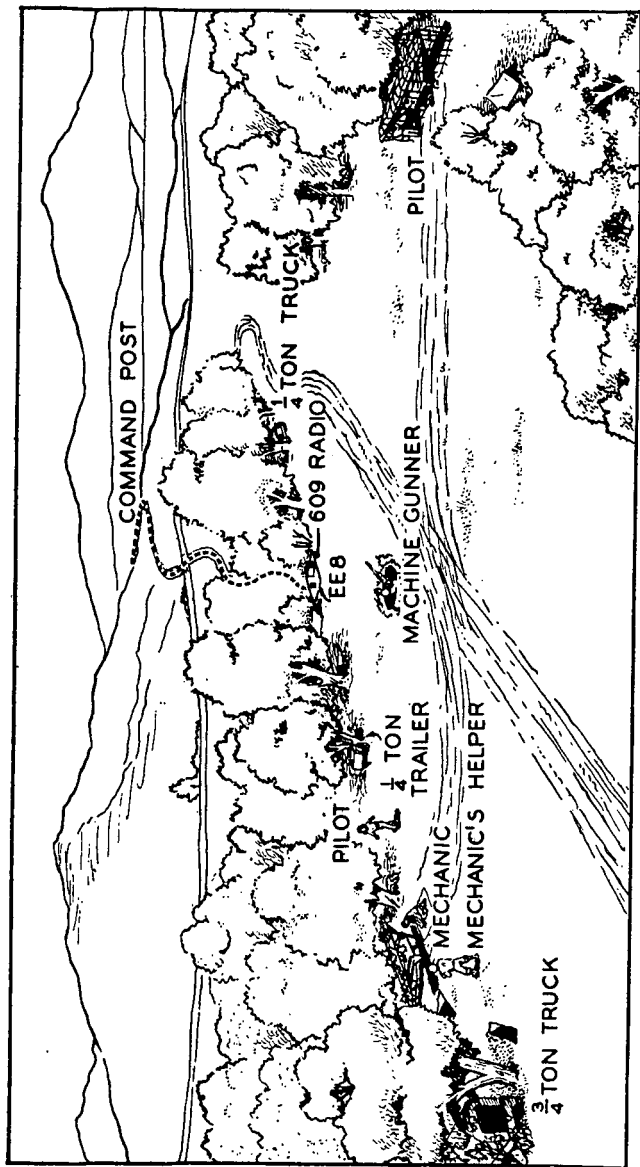


FIGURE 12. Organization of a landing field.

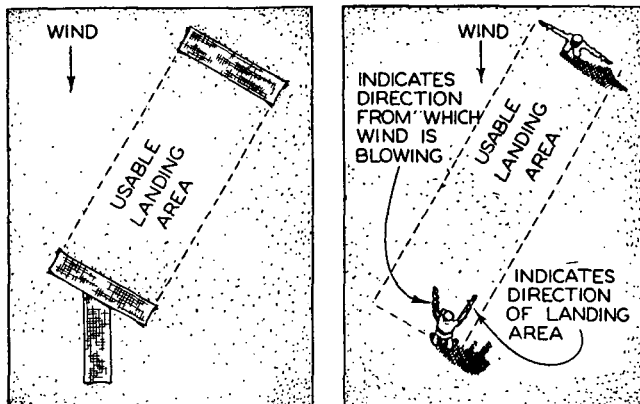


FIGURE 13. Marking landing strips.

(b) As soon as the airplane is landed, the ground crew lift the tail and turn the airplane around, thus preventing a telltale loop at the end of the strip (fig. 11). The pilot taxis the airplanes to concealment, guided by one man at each wing tip and another at the tail.

(2) *Take-off.* Prior to each take-off, the airplane engine should be warmed up and a communication check made. Guided by the ground crew, the pilot taxis to the downwind end of the strip. The airplane is turned by the ground crew who lift and swing the tail. Local anti-aircraft defenses should be notified of the planned mission and take-off time.

21. AIR SECURITY. While in flight, the airplane and its occupants are most vulnerable to enemy attack both from the ground and from the air.

a. Security from enemy aircraft. Although the air OP may derive some measure of protection from friendly fighters, the manner in which the mission is flown, and evasive maneuvers, the most reliable protection is provided by an advance warning system. A pilot who is warned in time can usually avoid attack. Practical

operation of the air OP will be greatly influenced by the air situation (relative air superiority held by the enemy or friendly forces) and habits of the enemy with respect to attacking air OPs in the local area.

(1) An effective warning system should include:

(a) *Unit air warning net.* Before the airplane takes off, all radio stations of the unit should be instructed to watch for enemy aircraft and to break into the net with a warning if any are sighted (fig. 14).

(b) *Air sentries.* In addition to the air sentry sent out from the landing field, battalion air sentries should be in close contact with a radio.

(c) *Antiaircraft artillery intelligence service.* Whenever possible, the unit should tie into the antiaircraft artillery warning service net. Antiaircraft radar sets are capable of locating aircraft at considerable distances and can afford the air OP adequate warning.

(d) *S-2 warnings.* By informing the air OP of all recent enemy air activity and of intended friendly air operations in the sector, the unit S-2 can help keep the pilot out of the air when the risk is greatest.

(2) *Liaison with air forces units.* Information pertaining to unusual operations, or changes in operations, of liaison airplanes in a sector should be transmitted through the air information and request radio net of each army so that the appropriate tactical air command can inform the air forces units concerned.

(3) *Flying missions.* The ability of fighter pilots to detect liaison airplanes in flight depends primarily upon two factors—the vertical distance between two airplanes and the light conditions. When the vertical distance between the two airplanes exceeds 5000 feet, the liaison airplane is not likely to be seen by the higher flying fighter. The shadow of a low-flying airplane can generally be detected much sooner than the airplane itself.

(4) *Evasive tactics.* Once aware of imminent attack by enemy aircraft, the pilot's safety depends on the maneuverability of his airplane and the speed with which

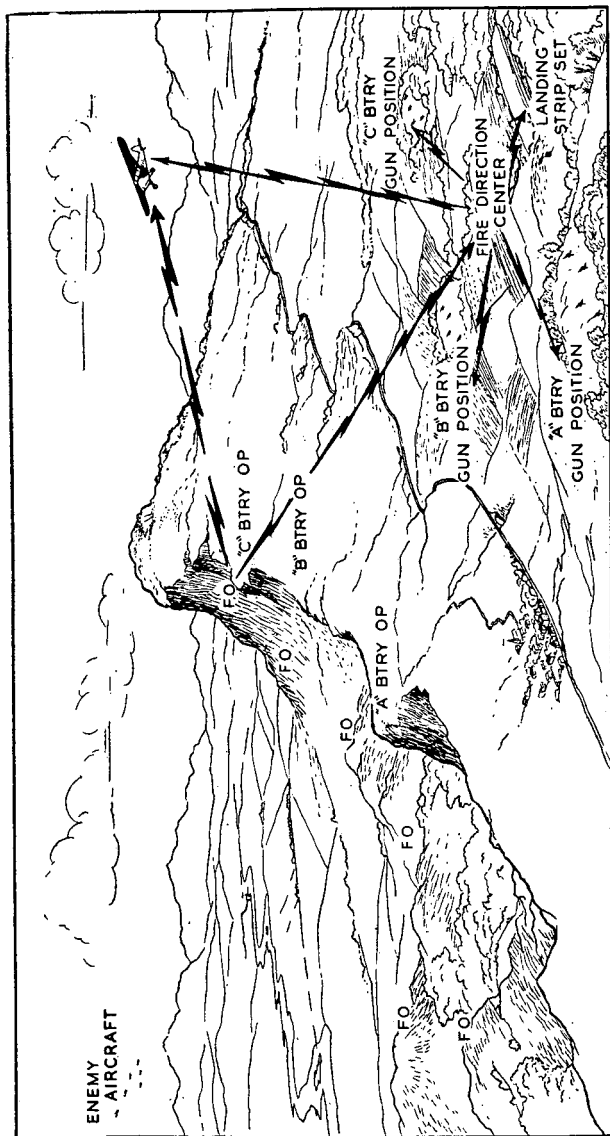


FIGURE 14. Aircraft warning system.

he effects a landing. Because landing is normally a slow procedure, he may prefer to dive for the ground and fly contour. In contour flying, the pilot takes advantage of stream beds, valleys, tree lines, and low hills for concealment. The pilot may also fly near friendly anti-aircraft positions, thus bringing the enemy pursuit within range of friendly fire.

b. Security from enemy ground fire. By varying the locality in which he flies missions and by changing his flight path widely during each mission, the pilot may prevent hostile troops from anticipating the time and position of his next appearance. Whenever practicable, the pilot should attempt to fly all missions outside the effective range of known enemy ground positions.

22. DISPLACEMENTS. The procedure for displacing the air OP will vary with terrain conditions, distance, and the time available for displacing. Senior liaison pilots should be notified early of any intended displacement of their unit so that they may have an airplane ready for operation at the new landing field as soon as the unit is in position. (See also chapter 5.)

a. General procedure in displacing the air OP.

(1) Field artillery commanders selecting a new position should consider the availability of suitable fields for the operation of liaison aircraft and promptly inform the senior pilot of the unit as soon as the new position has been selected in order that landing strips or temporary flying fields may be quickly located and established.

(2) Whenever possible, pilots make the ground reconnaissance; the observer or mechanic or other highly qualified personnel may substitute if necessary. During the reconnaissance, close attention must be paid to possible routes for guiding the vehicles of the air OP to the new strip.

(3) Ground crews proceed to the new strip immediately and begin necessary improvements. The airplanes may then be brought forward by:

(a) Radio to a pilot at the old landing field.

(b) Sending a member of the ground crew back with the necessary instructions.

(c) Following a predetermined time of departure, provided accurate estimates can be made of the time necessary for reconnaissance and improvement of the new landing strip.

(4) The airplanes displace one at a time, approaching the new field at a low altitude to avoid disclosing its location.

(5) Radio communication with the unit is maintained so that the pilot may be informed of any new developments.

(6) When night displacements can be anticipated, the pilot makes his reconnaissance during the day. The ground crew displaces with the unit and improves the landing strip that night or the next morning. The airplanes can then displace early in the morning in accordance with prearranged plans.

(7) As soon as the landing field is ready for operations, the S-3 and the headquarters battery commander are notified.

b. Example of typical displacement:

The senior liaison pilot has learned the hour of the intended displacement and the general area for his landing field. Accompanied by a mechanic, he flies to the assigned area and, from the air, selects tentatively two or three strips. On the return flight, they carefully check the road nets for access to each of the tentative strips. The mechanic makes a sketch of the routes. The pilot and mechanic repeat the reconnaissance on the ground, in conjunction with the unit reconnaissance. At this time, they select the best of the tentative strips.

On returning to the old landing field, the pilot decides on a prearranged time and interval for radio com-

munication as well as a code phrase for calling the airplanes forward. Then, with their equipment loaded, the ground crew proceed by vehicle to the new area and begin improving the field. When ready, the mechanic radios the pilot of the first airplane that the strip is prepared for operation. The second airplane takes off 10 minutes after the first has departed. Each airplane is camouflaged as soon as it is landed. The pilot of the first airplane, which carries the observer, informs the S-3 and communication officer of the field location.

23. LOCATING TARGETS.

a. Air methods compared with ground methods.

Air observation differs from ground observation with respect to the location of targets in the following particulars:

(1) Air observation permits less time for study of the target from any one position. The air observer must rely largely on experience and training to aid him in recognizing and locating targets without undue delay.

(2) The air observer is not limited to a small area for observation. If the target cannot be located from one position, the air observer can move rapidly to a more advantageous position.

(3) Defilade seldom prevents observation from the air OP.

b. Types of targets. The type of target which the air OP will most frequently be called upon to locate is the enemy artillery. Various tricks of spotting are used; pilot and observer look for:

- (1) The actual guns.
- (2) Smoke and flash.
- (3) Cleared areas in woods or tree clumps.
- (4) Vehicles moving into an area.
- (5) Faulty camouflage.
- (6) Activity of personnel.
- (7) Vehicular tracks in fields and paths converging on any point.

c. Positions for locating targets. The best position for air observation is that which permits adequate target identification and affords a reasonable degree of safety. Positions may be sought directly above or at either flank of the friendly battery. Unless it is necessary to fly higher in order to avoid hostile ground fire, observation will prove most satisfactory from low altitudes.

d. All targets located are reported to the S-2 or fire-direction center.

24. ADJUSTING ARTILLERY FIRE.

a. Targets. Since the position of the airplane with respect to the target is constantly changing, the air observer must make allowances for variations in the target offset. Visualization of the gun-target line requires continuous practice. To prevent losing the target when the airplane is turned, a well defined reference point on the ground should be used.

b. Bursts. Location of bursts from the air may prove difficult because, instead of the horizon, the terrain is the background. Smoke shell will produce bursts which are readily visible. As an aid to observer and pilot, the fire-direction center may employ a signal, such as "Splash," to indicate the end of the time of flight. A time-of-flight signal is especially necessary when long-range artillery is being adjusted, as it gives the pilot time to maneuver for a favorable position from which to observe the burst.

c. Prearrangement and conduct of fires. See FM 6-40.

25. RECONNAISSANCE OF POSITION AREAS AND ROUTES OF MARCH; MARCH CONTROL.

a. Reconnaissance of position areas and routes of march. In addition to or in conjunction with information obtained from ground reconnaissance, unit commanders may wish to secure information which is readily determined from the air, such as:

- (1) Alternate routes of approach and departure.
- (2) Condition of roads and bridges along the march route.
- (3) Assembly areas.
- (4) Defiladed areas.
- (5) Indications of mined areas.
- (6) Areas offering heaviest natural camouflage.
- (7) Broad view of the assigned sector.
- (8) Possible position areas.

b. March control.

(1) *Employment.* In training, the commander can supervise unit movements from the air. More effective march control can be obtained by using liaison airplanes. March control from the air provides valuable training for personnel of the air OP and an excellent vantage point for the commander who wishes personally to check and control the movement. March control from the air is not employed extensively in the forward area of the combat zone.

(2) *Requirements.* For marches over great distance, numerous landing strips must be available to permit refueling the airplane and frequently to return the commander or observer to the march column. The air OP must carry sufficient fuel and rations. Radio communication must be established throughout the march column.

(3) *Limitations in combat.*

- (a) Suitable landing strips may be unavailable.
- (b) Adverse weather conditions.
- (c) Hostile air superiority.
- (d) One or both of the airplanes may be in use for fire missions or in the process of displacing.
- (e) Night marches cannot be controlled from the air.

26. OBTAINING INFORMATION OF FRIENDLY AND HOSTILE FORCES.

a. General. Worthwhile information by air observation requires a definite objective, careful and frequent

study of the terrain, and knowledge of the situation. The observer should at least know why he is being sent aloft, what he is to look for, and where he may expect to find it. Obviously, the individual best qualified for this type of mission is the unit S-2.

b. Information of friendly forces. The air OP is capable of locating or identifying:

- (1) Supported troops.
- (2) Front lines and any fluctuations in enemy positions.
- (3) Enemy-laid mine fields in newly occupied areas. (The mine field pattern may be identified by low-altitude observation of suspicious areas).
- (4) Progress and position of reconnaissance troops.

c. Information of hostile forces. Due to the mobility of the airplane and the opportunity it affords for viewing ground objects from many different angles, the air observer can often provide better information concerning the following items than can ground observers:

- (1) Enemy front lines.
- (2) Volume and direction of road traffic.
- (3) Indications of attack or withdrawal.
- (4) Signs of demolition work.
- (5) Appearance of new routes.
- (6) Condition of enemy-held roads and bridges.
- (7) Condition of rivers and river banks.

d. *On the completion of a mission the unit S-2 questions the pilot and observer.*

27. SECURITY PATROLS. A security patrol differs from a reconnaissance patrol in that the observer on reconnaissance works towards a clearly defined objective while the observer on security patrol has the broad mission of noting and analyzing whatever may influence the security of his unit. The range of the security patrol is generally limited by the range of its communication facilities. However, liaison airplanes can fly short distances beyond the range of their communication facilities.

ties, obtain information, and reestablish communication when they return within range of their communication facilities. Weather conditions and enemy air and anti-aircraft activities are important factors limiting the use of the air OPs for security patrol missions.

Security patrols should be of short duration. They can be used to best advantage when the unit is moving through a corridor or cross-compartment or when it is fighting with an exposed flank. *Example:* An infantry division was operating at the mouth of a corridor. An exposed flank was anchored to a chain of hills which extended for twenty miles to the nearest friendly rear base. A one-hour patrol, three times daily, was organized to watch over the exposed flank. As a result, an attempt by enemy infantry to infiltrate through the hills was frustrated and effective fire was brought down on the enemy supply route.

28. CAMOUFLAGE CHECKS.

a. GENERAL. The value of the air OP for checking camouflage and camouflage discipline lies in its ability to observe friendly troops and installations from the angle of the enemy observer both on the ground and in the air.

b. Procedure. Camouflage checks should be initiated as soon as the unit is in position. Recommendations to the unit commander should be thorough and prompt. The usual camouflage-check mission is flown in three phases:

(1) Well forward and at about the same altitude as known or probable hostile observation posts.

(2) Directly above the unit position, at considerable altitude, to obtain the perspective of enemy aircraft.

(3) At low altitudes.

CHAPTER 5

SPECIAL OPERATIONS

29. GENERAL. As defined in FM 6-20, special operations are those in which terrain, weather, or nature of the operation creates the need for special measures and techniques. See also FM 100-5.

30. NIGHT OPERATIONS. Providing there is sufficient moonlight illumination, visibility, and ceiling, so that prominent terrain features are identifiable, the air OP can be used effectively at night.

a. Employment. Missions are somewhat limited by the number of terrain features identifiable at night. All missions are flown at higher altitudes (2000 to 3000 feet).

(1) *Fire missions:*

(a) *Counterbattery.* Active gun batteries are clearly revealed by their flash. The observer must tie in the location of the flash with respect to visible terrain features so that he will not lose the target at each lull in firing.

(b) *Interdiction.* Roads, road junctions, streams, and bridges show up clearly enough from the air to be taken under fire. These terrain features are generally visible with the moon in a phase from half to full, providing there is no restricting cloud cover or restricted visibility.

(c) *Defensive fires.* Fire can be laid down accurately on possible enemy assembly areas and avenues of approach.

(2) *Intelligence missions.* General information concerning movements and road traffic are obtainable.

b. Requirements for night operations. To overcome the additional hazards and problems involved in night operations, special arrangements must be made.

(1) *Coordination with other units and the Air Forces.*

(a) To minimize the danger of collisions in the air, a higher headquarters such as corps will coordinate the flights with the Air Forces. Different altitudes and sectors should be assigned to the various units in the command.

(b) Arrangements should be made to inform the observer of all friendly firing within his zone of observation. At night, shell bursts and gun flashes may appear similar from the air. The observer should know where friendly fire will be falling so that he will not confuse friendly shell bursts for enemy gun flashes.

(c) Plans for all night flights will be coordinated through air liaison channels of divisions and corps up to army, which is responsible for coordinating with the appropriate tactical air command.

(2) *Landing fields.* Approaches to fields should be cleared of obstacles, as far as possible, and fields should be defiladed from enemy ground observation, if possible, because landing lights will usually be used to guide in the airplane. (Figure 10 shows a method of lighting a combat field for night operations.) On bright moonlight nights, very little landing light is needed. These should be used only for landings and take-offs. Ground crews should be prepared to exhibit briefly a strong light to help returning pilots find the field. These lights should be flashed only on request of the pilot.

(3) *Airplane equipment.* The airplane should be equipped with luminous instruments one of which is a bank and turn indicator. Position lights are not required in combat flying but must be used in all other night operations. The equipment should include a flare gun for use in emergencies or for answering a challenge with the flare signal of the day.

(4) *Pilot and observer.* Both pilot and observer must thoroughly familiarize themselves with the target area and all of the terrain leading back to their landing field area. They should select terrain features, which will be visible at night for use as reference points, and several fields which may be used in case of a forced landing. The observer must improvise a method of illuminating his maps and photos without creating bright light in the cabin of the airplane (fig. 15). The use of a red light will least impair the ability of pilot and observer to see outside the airplane.

31. AMPHIBIOUS OPERATIONS.

a. General. In the initial stages of amphibious operations, the air OP may be employed not only in its normal role (par. 1) but also in the adjustment of naval gunfire and for directing land parties. The airplane may be sent ashore at any time, depending upon its role in the operation. The method of moving the airplane ashore will also depend upon its intended use; generally, it will follow one of four plans:

(1) The disassembled airplane may be transported to the beachhead by boat.

(2) It may be flown to the beachhead from a nearby land base.

(3) It may be flown from the flight deck of an aircraft carrier or other ship converted for this purpose.

(4) Seaplanes may be transported by vessel and flown from the water.

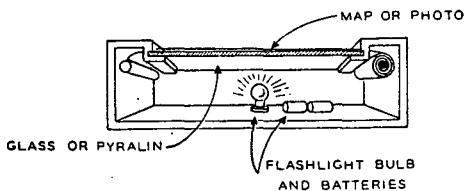
b. Transporting the disassembled airplane to the beachhead by boat:

(1) *Plans and training.* Before an amphibious operation is undertaken, plans should be complete for and personnel thoroughly acquainted with:

(a) The immediate role of the air OP.

(b) The type of landing vessel to be used, loading and unloading procedure, and assembly and disassembly of aircraft.

A LIGHT IS PLACED IN A WOODEN BOX WHICH HAS A GLASS TOP AND A ROLLER AT EACH END. THE MAP OR PHOTO CAN BE CUT IN STRIPS AND WOUND ON THE ROLLERS



a



b

FIGURE 15. Methods of illuminating maps and photos for night operations.

(c) The number of aircraft needed in the early phases. A unit may not require more than one airplane. The second airplane can be brought in with later elements.

(d) Individuals to be used in the initial landing. The airplane, pilot, ground crew members, and, whenever possible, the observer should always be transported on the same vessel.

(e) The equipment and fuel to be carried on the vessel with the airplane. The $\frac{3}{4}$ -ton truck and $\frac{1}{4}$ -ton trailer should be stocked with sufficient parts to facilitate minor repairs and with fuel for use in the airplane after it is reassembled.

(f) Communication. Before embarkation, proper radio installations and checks should be completed.

(2) *Loading.* The LST (landing ship, tank) is an appropriate type of vessel for transporting liaison airplanes. The disassembled airplane can be loaded and secured on either the upper or lower deck or loaded on a $2\frac{1}{2}$ -ton truck to be carried on the ship.

(a) *Loading on upper and lower deck.* Before the airplane can be rolled aboard the LST, the wings must be removed and placed in properly constructed wing racks which can be loaded alongside the airplane. On either deck, the airplane should be firmly secured in three places by means of deck moorings: Around the axles of both wheels and at the tail lift handle or tail wheel assembly. If placed on the upper deck, the airplane should be securely covered to protect it against sea water.

(b) *Loading on a $2\frac{1}{2}$ -ton truck* (figs. 25 and 26). This method of loading has several advantages:

1. Less chance of damaging the airplane.
2. Accelerates loading on and unloading from the vessel.
3. After debarkation, the airplane can be transported to the assembly area without being removed from the truck.

(3) *Unloading.* Once on the beach, the airplane should be removed to a concealed position and reassembled as soon as it is reasonably safe to do so. If the beach is so badly cut up that the airplane cannot be flown off, it should be transported to a usable road or runway. Airplanes not loaded on vehicles will require manhandling on the beach and towing to an assembly area.

c. Flying the airplane from a nearby land base.

Prearrangement is essential:

(1) A competent individual must be charged with selecting and preparing a suitable field on which to receive the airplane.

(2) The approximate location of the field, identified on a map, air photo, or overlapping air photos, should be known to the pilot in advance.

(3) Provision should be made for necessary personnel and equipment to join the pilot and airplane as soon as possible.

(4) Communication channels and signals should be coordinated in order that the pilot may be directed to the field upon completion of his immediate mission.

d. Flying the airplane from the deck of an aircraft carrier. Prearrangement is the same as for c above. Because the airplane can be launched early during the landing operations, this procedure is highly desirable. Difficulties are presented however when the airplane is launched from a position many miles off shore. Without proper instruments, aerial navigation is particularly difficult over large bodies of water and the pilot may have trouble locating his unit once he reaches shore. The airplane can also take off from a runway constructed on the deck of an LST (fig. 16).

e. Transporting seaplane by vessel and flying from the water. When seaplane floats are available and the pilot has had seaplane training, seaplanes can be used effectively in amphibious operations.

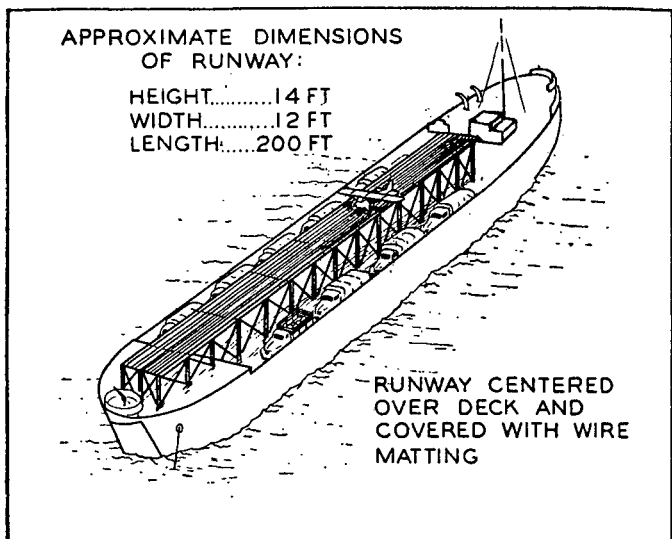


FIGURE 16. Runway constructed on the deck of a landing ship, tank.

(1) *Loading on vessel.* Seaplanes can be deck-loaded on transports or freighters. Some form of dolly should be constructed to support the weight of the airplane and keep the floats from contact with the deck. The airplane should be carefully secured to the dolly and the dolly securely moored to the deck.

(2) *Unloading.* The airplane may be lowered over the side of the vessel by power machinery; however, great care must be exercised. Unloading should not be attempted if there is much wind: The airplane tends to react like a weathervane and can be damaged easily against the side of the vessel.

(3) *Flying from the water.* Because of the construction and light weight of liaison aircraft, seaplane operations should be attempted only on smooth water. When possible, take-offs should be made from leeward. Operations should not be attempted if high swells or whitecaps are running.

32. OPERATIONS IN THE JUNGLE (FM 31-20). The dense growth typical of the jungle restricts ground observation and increases the need for effective air observation.

a. Employment of the air OP. Most long-range firing, including counterbattery, will be conducted from the air. Friendly infantry mortars and assault guns may also be adjusted. The difficulties encountered in ground travel indicate use of the airplane to drop messages to patrols and forward observers. In extreme emergencies, ammunition and supplies may also be dropped to them. Security patrols may be used to great advantage.

b. Target location and observation. Locating and observing targets in the jungle may be difficult. For the most part, missions will have to be flown at extremely low altitudes, often directly over the target. Adjustment with smoke shell is frequent.

c. Landing fields. Prevalence of swamp and heavy growth limit the number of landing fields available. Often the air OP will operate from advance bases of high-performance aircraft. Landing strips in the vicinity of the units may have to be cleared and constructed with heavy engineer equipment. Pontoon equipped aircraft can use strips of water.

d. Displacements. The scarcity of landing fields may prevent the air OP from displacing with its unit. It may continue to operate from a convenient rear base while the unit displaces repeatedly.

e. Maintenance.

(1) Metal members may rust. They should be checked carefully and refinished when necessary.

(2) Spars and other wooden parts may warp and rot. These should be subject to regular inspections. Wings should also be checked frequently for rigging.

f. System of operation. Because of the scarcity of landing fields and the problem of supply, occasionally

the air OP may have to operate under centralized control (par. 34c).

33. DESERT WARFARE (FM 31-25).

a. Observation. Over treeless, flat terrain, air observation is excellent. Because of the scarcity of defilade, targets can be located easily. Most fire missions can be conducted from a very low altitude close to the battery position. Precautions must be taken not to disclose the battery position by habitually following the same flight path in its vicinity.

b. Additional types of employment.

(1) The distance between units is frequently so great that the liaison airplane may become an important means of communication and control.

(2) Security patrols may be used to watch over exposed flanks. On approach marches, the air observer is useful for reporting the location and movements of the enemy.

c. Displacements. In the desert, displacements cover relatively great distances; the pilot must be prepared to fly 75 miles or more at contour altitudes. When the unit displaces at night, the air OP may be unable to rejoin it until the next day.

d. Camouflage and concealment. Desert terrain provides scant concealment or camouflage for the airplane and landing field. In the air, the liaison airplane is especially vulnerable to attack by enemy aircraft.

(1) *Landing fields.* Care must be exercised to refrain from making obvious or unnecessary improvements which are easily spotted from the air. Alternate fields to the rear should always be selected and improved. In fluid operations, it is often necessary to fly the airplane to the alternate field at night and return to the forward field the next morning. Use of an alternate field may prevent stranding of the airplane if the unit should be withdrawn during the night.

(2) *Airplanes.* On the ground, airplanes are dispersed widely, their outlines broken by any means available. Camouflage nets which blend with the terrain, thatched huts, and sand dunes provide effective concealment.

e. Maintenance. Heat, sand, and wind complicate the problem of maintenance in the desert. The fabric of the airplane may require regular rejuvenation with coats of dope. Oil must often be changed after 8 or 10 hours of operation. Wooden members such as spars will crack and warp. Frequent inspection of all wooden members and rigging of the wings is necessary to prevent structural failures in flight.

34. MOUNTAIN WARFARE.

a. Employment of the air OP.

(1) Because of the difficulties involved in ground reconnaissance, the air OP will be used more frequently for reconnaissance of position areas and routes of march.

(2) Hostile artillery, mortars, and assembly areas can be observed from the air although concealed from ground observation by intervening ground forms.

(3) Courier and liaison missions may be more frequent.

(4) In extreme emergencies, the liaison airplane has been used to drop supplies to forward observation personnel isolated on mountains or in positions otherwise inaccessible.

b. Operational problems:

(1) *General.* Pilots will have to fly at unusually high altitudes, diving for mountain tops as a means of defense. Care must be exercised to stay clear of high-angle trajectories. Because of distance and terrain factors, it will seldom be possible for the observer or pilot to remain at the unit command post. S-2 and S-3 briefing can be carried on by telephone. An accurate situation map should be kept at the landing field.

(2) *Communication.* Because of increased distances and line-of-sight characteristics of air OP radios, a strong base radio set (one of the higher rated sets of the bat-

talion) is needed at the landing field for communicating with the unit and for the proper functioning of the air warning system. It may often be necessary to use relay stations. When direct wire communication with the unit is impracticable, lines may be laid to a switching central.

(3) *Landing fields.* Landing fields are scarce. It may often be desirable for the airplanes of several units to operate from the same landing field.

c. Centralized operation. In mountain warfare it is sometimes necessary to operate the airplanes of a division or group from one field under centralized control. When operating air OPs under centralized control, the senior field artillery commander, assisted by his artillery air officer, is guided by the following principles:

(1) *Coordination of missions.* As far as possible, control and employment of the air observation should be left with the unit commanders. However, to prevent unnecessary duplication of missions, flights should be coordinated. An airplane should not be sent aloft if its mission can be accomplished by another airplane already in the air.

(2) *Organization of landing fields.* Camouflage and dispersal must be carefully planned to accommodate the additional airplanes and equipment involved in centralized operation. If camouflage and dispersal areas are inadequate, it may be advisable to keep some of the airplanes at another field well to the rear. A field headquarters, complete with communication facilities and situation maps, should be set up at a central location. Pilots and observers should be required to check in and out on each mission, being careful to note all changes in the situation and to report all information obtained.

(3) *Displacement.* Usually there will be sufficient time for thorough air and ground reconnaissance and a well staggered displacement. Selection of the field should be the duty of the artillery air officer and his crew. Equipment should not be moved to the new field any faster than it can be effectively concealed there.

(4) *Mess and supply*..Supply of rations and fuel should be coordinated and a central messing system established.

CHAPTER 6

SUPPLY, ADMINISTRATION, AND MAINTENANCE

35. GENERAL: Field artillery unit commanders are responsible that a complete file of appropriate Army Air Forces publications, to include technical orders and Army Air Forces regulations pertaining to maintenance and operation of field artillery liaison aircraft, is maintained in the unit.

36. SUPPLY.

a. The air OP is an organic part of the headquarters battery of a unit and, as such, obtains all its equipment and supplies through normal supply channels. The headquarters battery commander is responsible that the equipment and supplies of the air OP are obtained as required. When an airplane is temporarily away from its home station, necessary spare parts, supplies, maintenance, fuel, publications and information can be obtained from the most convenient Army Air Forces installation.

b. In Continental United States.

(1) The Commanding General, Army Air Forces, is responsible for the supply of Army Air Forces equipment to Army Ground Forces units in the continental United States.

(2) Initial issue of equipment and supplies is automatic. Requests for replacement airplanes will be made through command channels to the Commanding General, Army Ground Forces. Requisitions for replacement of associated airplane equipment will be made on Army Air Forces Form No. 102. Requisitions will be submitted

to the post, camp, or station Air Forces property officer, except in emergencies. If an emergency develops, when an airplane is temporarily away from home station, equipment and supplies may be drawn from the nearest Army Air Forces installation.

c. In overseas theaters. Supplies and equipment will be drawn from the Army Air Forces Depot Unit (Army) or other installation designated by the theater commander.

37. ADMINISTRATION. Headquarters battery commander is responsible that the required forms and records are properly kept.

a. The following forms and records will be kept by air observation personnel in accordance with applicable Army Air Forces regulations and technical orders:

<i>Form No.</i>	<i>Title</i>
1	Flight Report—Operations.
1A	Flight Report—Engineering.
5	Individual Flight Record.
41B	Maintenance Inspection Record.
46	Parachute Log Record.
60A	Historical Record, Airplane.
60B	Historical Record, Engine.
61	Historical Record, Propellers.

(1) The pilot is responsible for the completion of Army Air Forces Forms 1, 1A, 41B, 46, 60A, 60B, and 61.

(2) Army Air Forces Form 5 is kept in duplicate for each pilot. The senior pilot is charged with the correct transcription of flight time from Army Air Forces Form 1 to the Army Air Forces Form 5 of the unit pilot concerned. At the end of the month, the unit commander will ascertain and certify to the correctness of the Army Air Forces Forms 5. The original is filed in unit headquarters, together with copies of all orders affecting the flying status of the individual. The first carbon copy, certified as to correctness by the unit commander, is fur-

nished the pilot for his personal records. When a pilot is transferred to another unit, his Army Air Forces Form 5 and the file of orders affecting his flying status accompany him. In case of the pilot's death or relief from flying status or active duty, this file will be forwarded through channels to the Adjutant General.

b. Accident reports. Reports of major aircraft accidents and damage are made as prescribed in AR 95-120 and current instructions from the Commanding General, Army Ground Forces. No report is required of accidents involving only minor damage to aircraft.

c. Inspection and disposal of records. Commanders of corps and division artillery will authorize the inspection and destruction of records after they have been kept the required length of time.

d. Unsatisfactory report. Army Air Forces Form 54, Unsatisfactory Report, will be prepared and forwarded as prescribed in Army Air Forces Regulations 15-54 when any of the following is ascertained (one copy will be sent to the Commanding General, Army Ground Forces):

(1) Failure or malfunctioning of any item of Army Air Forces materiel or equipment.

(2) Unsatisfactory design of any item supplied by the Army Air Forces.

(3) Defects due to faulty materiel, workmanship, or inspection.

(4) Unsatisfactory maintenance methods prescribed in Army Air Forces technical publications.

e. Physical fitness of pilots.

(1) *General.* Commanding officers of field artillery units are responsible for the physical fitness for flying of field artillery liaison pilots. Unit commanders will be guided in their actions regarding the maintenance of the physical well-being of pilots by the recommendations of the unit surgeon. Field artillery unit surgeons will communicate with flight surgeons and aviation medical

examiners of the most accessible Army Air Forces installation or unit on matters concerning aviation medicine and the care of flying personnel. Army Air Forces flight surgeons and aviation medical examiners will render technical advice and assistance in the care of field artillery liaison pilots when requested to do so by field artillery unit surgeons.

(2) *Physical examination for flying.* Standards of physical examinations for flying will be as provided in AR 40-110. All physical examinations for flying (W.D., A.G.O. Form No. 64, Physical Examination for Flying) will be conducted by flight surgeons or aviation medical examiners certified by the Commanding General, Army Air Forces, as currently qualified to perform such examinations. All pilots holding an effective aeronautical rating and currently on active flying status will be given a physical examination for flying once each year, in addition to other required physical examinations. Physical examinations will be conducted by Army Air Forces flight surgeons and aviation medical examiners only upon oral or written request of the field artillery unit commander or unit surgeon.

(3) *Relief from and restoration to flying status.* Suspensions and removal of suspensions from flying status will be accomplished in accordance with the provisions of Executive Order 9195, 7 July 1942 (par. 2, AR 35-1480). The Commanding General, Army Ground Forces, and the commanding generals of overseas theaters of operations having field artillery liaison pilots assigned to their commands, are authorized to confirm suspensions from flying status and revocations of suspensions from flying status of liaison pilots.

(a) *Relief from flying status.* A commanding officer will suspend from flying status any individual of his command who, in his opinion, is unfit for flying, except when the unfitness is the result of an aviation accident (Executive Order 9195). In case of an aircraft accident no suspension of flying status will be accomplished until

a period of 3 months has elapsed subsequent to the month in which the individual last met flight requirements. In recommending removal from flying status, the type of suspension will be determined by estimating the approximate period of time the individual will be unable to perform flying duties. Such recommendations will indicate definitely the period of suspension. *Examples:* "Grounding" for periods under 30 days; "suspension" for periods over 30 days. Relief from flying status will be accomplished in the following manner:

1. *Grounding* will be relief from flying status for a period not expected to exceed 30 days and which is imposed because of a minor illness or injury, as defined in AR 40-110, and not the result of an aircraft accident. The commanding officer of a field artillery unit will ground an individual upon advice of the unit surgeon without reference to higher authority. Such action will be accomplished by written order of the unit commander. When a *grounding* order by the commander of a field artillery unit exceeds a period of 30 days, such grounding will become a *suspension* and will be reported for confirmation as indicated below.

2. *Suspension* will be relief from flying status for a period expected to exceed 30 days; it will be accomplished by written order of the unit commander. In all cases such action, with reasons therefor, will be reported for confirmation to the Commanding General, Army Ground Forces, or to the theater commander concerned.

(b) Restoration of flying status will be accomplished in the following manner:

1. Removal of *grounding* will be accomplished by written order of the commanding officer of the field artillery unit, upon the recommendation of the unit surgeon, without reference to a higher authority.

2. Removal of suspension from flying status will be accomplished by written order of the unit commander when, in his opinion, the individual so suspended again

becomes fit for flying. This action, with reasons therefor, will be reported for confirmation to the authority who confirmed the suspension from flying. Removal of suspension from flying status resulting from physical disqualification(s) will be initiated when an Army Air Forces flight surgeon or aviation medical examiner has found the individual physically qualified for flying.

(c) Evaluation of pilots. If a unit commander questions the flying ability of a pilot assigned to the headquarters battery of his unit, the pilot may be ordered on detached service to the nearest Army Air Forces station for the purpose of appearing before a flying-evaluation board. The flying-evaluation board will be conducted in accordance with pertinent Army Air Forces regulations. Complete details regarding the flying deficiency of the individual concerned will be furnished the flying-evaluation board by the unit commander. The flying-evaluation board proceedings and recommendations will be submitted through Army Air Forces command channels to the Commanding General, Army Air Forces. The Commanding General, Army Air Forces, will place his recommendations thereon and forward the report to the Commanding General, Army Ground Forces, who will direct final action in all such cases.

(4) Medical records:

(a) The unit surgeon will maintain a complete medical record of each pilot assigned to the unit, to include all reports of physical examination for flying, reports of consultation with Army Air Forces flight surgeons and/or aviation medical examiners, copies of orders pertaining to grounding and/or suspension for physical reasons, and W.D., M.D. Form No. 79 (Register of Dental Patients).

(b) Report of physical examination for flying (W.D., A.G.O. Form No. 64).

1. In the continental United States report(s) of physical examination for flying will be forwarded by Army Air Forces flight surgeons and/or aviation medical

examiners, in triplicate, direct to the Commanding General, Army Air Forces, for certification. The unit to which the pilot is assigned will be clearly indicated thereon. Certified copies and appropriate recommendations will be returned to the unit commander through the Commanding General, Army Ground Forces, by the Commanding General, Army Air Forces.

2. In theaters of operations, report(s) of physical examinations for flying will be forwarded for certification to the commanding general of the overseas air force concerned. The unit to which the pilot is assigned will be clearly indicated thereon. Certified reports and recommendations will be returned to the commanding officer of the unit to which the pilot is assigned, through the commanding general of the theater.

(c) Transfer of records.

1. When a pilot is transferred to another field artillery unit within the continental limits of the United States, the medical records referred to in *a* above will be forwarded to the commanding officer of the unit to which transferred.

2. When a pilot is transferred outside the continental limits of the United States, records referred to in (*a*) above will be forwarded to the Commanding General, Army Ground Forces, for file until such time as the pilot returns to the continental United States, when they will be requested by the commanding officer of the field artillery unit to which he is assigned.

38. MAINTENANCE.

a. General. The unit commander is responsible that first and second echelons of maintenance of the airplane are properly performed. The term "first and second echelon maintenance" includes all repairs and maintenance which the field artillery unit is capable of performing with the personnel, equipment, spare parts, time, and supplies available to it. Pilots and mechanics should be capable of effecting first and second echelon mainten-

ance. Maintenance beyond first and second echelon and supplies needed for first and second echelon repairs are furnished by the nearest field service element of the Army Air Forces. Each field artillery unit is authorized a kit of supplies necessary for the proper daily maintenance of its aircraft. Spare parts for the repair of airplanes and engines are available to the unit from the stock carried by the headquarters battery of the next higher headquarters.

b. In continental United States. The unit commander is responsible that first and second echelons of maintenance are properly performed. First and second echelon maintenance will be performed by pilots and mechanics. Higher echelon maintenance will be performed by the Army Air Forces installation designated by the Commanding General, Army Air Forces. Normally, this installation will be the one from which the post, camp, or station Air Forces property officer draws supplies. Each field artillery battalion is authorized one (1) kit, maintenance supplies, airplane, for the proper daily maintenance of its aircraft. Spare parts for the repair of airplanes and engines are available to battalions from the authorized stock carried by the headquarters battery of the next higher headquarters. Inspections and records required are: preflight, daily flight, 25-hour, 50-hour, and 100-hour.

c. In overseas theaters. First and second echelon maintenance will be the same as for units in continental United States. Normally higher echelon maintenance will be performed by the Army Air Forces Depot Unit (Army) or the Army Air Forces installation designated by the theater commander to serve ground forces units. Such unit or installation is normally located in the army service area.

d. Inspections and records.

(1) *Inspections.*

(a) The inspections prescribed are:
Preflight.

Daily flight.

25-hour.

50-hour.

100-hour.

At engine change.

25 hours after engine change.

(b) These inspections will be performed in accordance with Army Air Forces Technical Order 00-20A, covering visual inspection system for airplanes.

(2) *Records.* Records required by Army Air Forces Technical Order 00-20A will be kept as directed in those orders.

e. Principles governing first and second echelon maintenance. Airplanes and engines are maintained in accordance with Army Air Forces technical orders, handbooks of maintenance instructions, or service manuals covering the type airplane and engine assigned.

f. Maintenance above second echelon. When overhaul or maintenance above second echelon is required, Army Air Forces Forms 41B, 60A, 60B, 61, historical data, and such information as is necessary must be furnished by the field artillery unit.

g. Gas and oil.

(1) Standard aviation gasoline, preferably of 73 to 80 octane rating, should be used when available. Otherwise, a good grade of truck gasoline of at least 73 octane rating may be used after any water or dirt has been removed.

(2) Standard aviation lubricating oil, as prescribed, should be used.

h. Unserviceable airplanes. Airplanes and other items of Army Air Forces property which become unserviceable through accident or in any other manner are disposed of in accordance with AR 35-6640.

APPENDIX I

LOCAL AIR TRAFFIC AND LANDING FIELD REGULATIONS

1. AIR REGULATIONS.

a. Traffic pattern.

(1) The traffic pattern will consist of a single counter-clockwise rectangular pattern at an altitude of 500 feet and extending approximately 2000 feet outside the boundaries of the field. See figure 17.

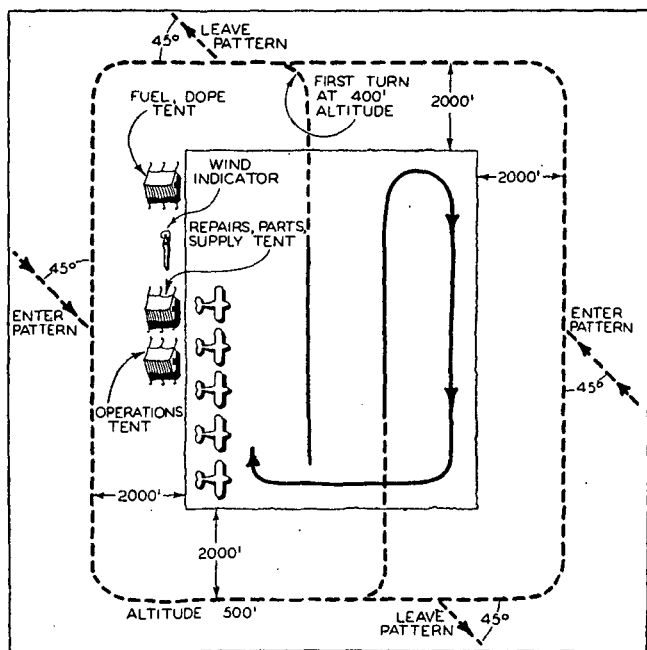


FIGURE 17. Local traffic pattern.

(2) Two legs of the pattern will be parallel to the wind direction, as indicated by the wind "T", and the other two legs will be perpendicular to the wind direction.

(3) Traffic in the pattern and within a radius of 1 mile of the base field will be counterclockwise. Within that radius all airplanes will fly so that the base field is on the pilot's left and so that no turns are made to the right except on entering or leaving the traffic pattern.

(4) Airplanes will enter the traffic pattern at approximately the center of the upwind or downwind leg, at 500 feet altitude and at an angle of 45 degrees to the leg entered, with a 45-degree turn to the right. Airplanes will then continue in the pattern; on the base leg, they will make a 90-degree turn to the left for final approach on a straight line into the wind. Except in high winds, the final approach will be power-off to a normal three-point landing at least 300 feet inside the boundaries of the field.

(5) Take-offs will be made with the wind "T", or as nearly so as possible. Take-offs over buildings or similar obstructions should be avoided whenever possible. After taking off, the airplane will continue in straight flight to an altitude of 400 feet, where it will make a 90-degree turn to the left. Airplanes may leave the traffic pattern on either of the crosswind legs at 500 feet altitude by making a 45-degree turn to the right, out of the pattern, and then proceeding on a straight course until at least 1 mile beyond the boundaries of the field.

b. Local flying area. The local flying area is designated as prescribed in AR 95-15.

c. Danger and caution areas. Flying over any of the areas listed below is forbidden. Each pilot is responsible for knowing the location of each of these areas.

(1) The post ammunition dump.

(2) All populated areas (unless the airplane is flying at an altitude of more than 1000 feet).

(3) The area within a radius of 3 miles of army air-fields (unless the airplane is flying at an altitude in excess of 1500 feet).

d. Altitudes.

(1) A minimum flight altitude of 500 feet above the ground will be maintained at all times except during landings, take-offs, area dragging, and contour flying.

(2) When dragging areas, the pilot will carefully select the flight path so that he can make a safe forced landing in case of engine failure.

(3) Contour flying will be practiced only by authority of the unit commander, in designated areas, and at designated times. Contour flying will habitually be done upwind.

e. Charts. Sectional charts for the area will always be carried in each airplane. Before departing on extended flights, pilots will provide themselves with sectional charts covering the proposed route and all areas for 25 miles on either side of the course.

f. Parachutes. Parachutes will be worn on all extended flights, for acrobatics, and on any flight during which the pilot intends to fly above an altitude of 1,000 feet.

2. GROUND REGULATIONS.

a. Taxiing.

(1) Pilots will execute a series of S-turns while taxiing.

(2) Taxi pattern will be in a direction opposite to that of the air traffic pattern.

(3) Pilots will refrain from taxiing across the landing area of the field. Insofar as possible, all taxiing will be done near the edges of the field.

b. Clearing turns. Before taking off, the pilot will habitually make a clearing turn in a direction opposite to that of the air traffic pattern.

c. Tie-downs. When not in use, airplanes will be kept tied down.

d. Chocks. Chocks will always be used when starting the airplane and when it is parked.

e. Moving airplanes. A man will be at each wing tip and at the tail of an airplane when it is moved in proximity to other airplanes or obstructions.

f. Starting. Airplanes will be moved away from the parking line before being started. A fire extinguisher will be readily available outside the airplane. All safety precautions will be observed and the starting signals will be given by the individual at the propeller. An airplane will not be started or left running unless a competent operator is at the controls. Airplanes will be started according to the following procedure:

(1) Priming.

(a) Man outside the cabin calls out:

1. SWITCH OFF;
2. GAS ON;
3. THROTTLE CLOSED (or CRACKED).

(b) Man inside the cabin:

1. Checks to insure that switch is off, gas is on, and throttle is closed or "cracked";

2. Repeats information in (a) above to the man outside the cabin.

(c) Man outside the cabin "pulls the propeller through" three or four times.

(2) Cranking.

(a) After priming is completed, man outside the cabin calls out BRAKES ON; CONTACT.

(b) Man in cabin:

1. Applies brakes;
2. Repeats "BRAKES ON; CONTACT";
3. Turns switch on immediately.

(c) Man outside cabin:

1. Makes sure of his footing, faces the engine and pulls the propeller through with both hands.

2. Backs away quickly until clear of propeller.

g. Warm up. Airplanes will not be flown until engines are warmed up according to directions given in

appropriate operating instructions pertaining to equipment being used.

h. Propellers. Except for the purpose of cranking, a propeller will not be touched for at least 15 minutes after engine operation.

i. Refueling. Airplane will be electrically grounded while refueling.

3. MISCELLANEOUS.

a. Preflight inspection. The pilot will perform the preflight inspection before the first flight of the day.

b. Loading. Under no circumstances will the crew weight exceed 340 pounds.

c. Weather. An airplane will not take off unless the weather is equal to or better than the minimums for contact flight outside of control zones.

d. Flight plans. Flight plans for extended flights will be filed in accordance with Army Air Forces Regulation 15-23. Pilots will use the following procedure in filing flight plans:

(1) When an established Army Air Forces or naval aviation operations office is available, the pilot will file and obtain approval of flight plan from the operations officer.

(2) Where no such military operations office is available, the pilot will file a flight plan with an Army Air Force flight control center. Civil Aeronautics Authority communication stations will transmit flight plans to Army Air Force control centers. From Army Air Force flight control, pilots must obtain approval and clearance of flight plan prior to departure.

(3) If no communication facilities are available, the pilot may take off and proceed to the nearest practicable location where communications are available, providing the flight can be made in accordance with contact flight rules (CFR). The pilot will file a flight plan and obtain

approval and clearance, in accordance with instructions given above, before continuing flight.

e. Local flying board. Before departing on local flights, pilots will sign out on the local flying board in the operations office. Immediately upon returning, pilots will sign in on the local flying board.

f. Operations office. Personnel will not enter the operations office except on official business.

g. Sulfa drugs. Personnel on flying status will not use any drugs of the sulfa group unless the use of such drugs has been specifically prescribed by a medical officer. Individuals who have taken any sulfa drug internally will not fly for a period of one week after the last administration of such drug.

h. Smoking. Smoking and open flame lights are prohibited within a radius of 50 feet of any aircraft, gasoline dump, fuel pump, fuel unit, and oil or dope storage dump or building. Smoking and open flame lights are likewise prohibited within 50 feet of any building or locality where dope is being brushed or sprayed.

i. Corrective lenses. Pilots who have been instructed by the flight surgeon to wear corrective lenses while flying will comply at all times.

APPENDIX II

CHECK SHEET FOR INSPECTION OF AIR OP

Section I. TRAINING

- 1.** Are training directives, programs, and orders adequate?
- 2.** Is training continuous, and directed at the elimination of bad flying habits and the improvement of flying technique, maintenance, and the technique of air observation?
- 3.** Is adequate transition training, where required, being conducted?
- 4. a.** Does flight training include practice in precision take-offs and landings:
 - (1) On roads?
 - (2) Between panels?
 - (3) Over simulated barriers?
- b.** Does flight training include training in evasive maneuvers?
- 5.** Do pilots make two or more cross-country flights per month?
- 6.** Does observer training for pilots and officers to be trained as observers include:
 - a.** Reading of maps and air photographs from the air?
 - b.** Orientation?
 - c.** Terrain appreciation?
 - d.** Air-ground communication?

e. Daily use of the terrain board with emphasis on correct radio procedure, speed, and proper methods of adjusting fire?

f. Simulated missions on a puff target range?

g. Conduct of fire from the air using forward observer methods?

7. Are designated personnel being trained:

a. In the selection and preparation of roads and fields suitable for use as landing strips?

b. In the concealment and camouflage of the airplane, the strips, and materiel?

c. In ground handling of aircraft?

8. Are observers and air OP personnel using the terrain plot to practice locating:

a. Suitable areas for landing fields?

b. Routes of access and supply to landing fields?

c. Best possible flight paths for flying missions?

d. Probable target areas?

9. Are satisfactory ground schools organized and conducted for pilots in these subjects:

a. Navigation?

b. Meteorology?

c. Air traffic rules?

d. Aircraft clearances?

e. Pilot's Information File and appropriate Army Air Forces forms, records, and technical orders?

10. Do air observation personnel go out frequently on tactical exercises for practical experience in:

a. Field reconnaissance for, selection, and organization of landing strips?

b. Display of panels?

c. Short-field flying technique?

11. Are all air observation personnel being trained in the use of small arms and the caliber .50 machine gun?

Section II. MAINTENANCE, SUPPLY AND ADMINISTRATION

12. Is proper care taken in handling spare parts, tools, aircraft supplies, and parachutes?

13. Are requisitions properly consolidated and forwarded through the prescribed channels?

14. Are the following forms properly maintained:

a. Army Air Forces Form 1, Flight Report—Operations?

b. Army Air Forces Form 1A, Flight Report—Engineering?

c. Army Air Forces Form 5, Individual Flight Record?

d. Army Air Forces Form 41B, Maintenance Inspection Reports?

e. Army Air Forces Form 46, Parachute Log Record?

f. Army Air Forces Form 60A, Historical Record, Airplane?

g. Army Air Forces Form 60B, Historical Record, Engine?

h. Army Air Forces Form 61, Historical Record, Propellers?

15. Are daily and preflight inspection made on airplanes; and are periodic inspections made at proper times (25 hours, 50 hours, 100 hours, etc.)?

16. Are 73-octane aviation gasoline and proper grades of aircraft oil being used?

17. Are airplanes and engines clean and free of accumulated oil and dirt? Check floors for cleanliness, windshields for clearness.

18. Is gasoline strained through a chamois, and is a suitable ground provided when the airplane is being refueled?

19. Are compasses swung every 100 hours or every 3 months, whichever is the lesser? (Army Air Forces Technical Order 05-15-3.)

20. Are parachutes inspected once every 10 days (as directed in Army Air Forces Technical Order 13-5-2); repacked by an authorized parachute rigger at least once every 60 days?

21. Are parachutes clean, handled carefully, and stored in a clean dry place?

Section III. OPERATION

22. Are the following publications on hand and available for reference:

a. Applicable War Department training circulars?

b. Air OP Memorandums, Army Ground Forces?

c. AR 95-120?

d. Appropriate Army Air Force publications, to include Pilot's Information File, and appropriate technical orders and regulations?

23. Have safety regulations and traffic pattern been prescribed and enforced?

24. Are all pilots familiar with local firing, restricted, and danger areas?

25. Are sectional aeronautical charts available for all extended flights?

26. Has the artillery air officer procured and distributed, as required, copies of applicable Weekly Notices to Airmen, Danger Area Charts, Directories of Airfields, Radio Facility Charts?

- 27.** Are new pilots required to familiarize themselves with local conditions of terrain and weather before attempting tactical or extended flights?
- 28.** Is an adequate record of aircraft accidents and damages maintained?
- 29.** Is an adequate record of missions maintained?
- 30.** Are adequate precautions prescribed and observed concerning mooring of aircraft, starting, refueling, ground handling, and similar operations?
- 31.** Is pilot's flying time limited to an average of less than 4 hours per day and less than 100 flying hours in any one month?

APPENDIX III

FLIGHT MANEUVERS

Section I. BASIC FLIGHT MANEUVERS

1. TAKE-OFFS AND LANDINGS. Normal take-offs, power-off landings, power-off spot landings from 90-degree and 180-degree approaches. Emphasis on control, coordination, and accuracy of landings.

2. COORDINATION EXERCISES. Rolling from bank to a bank with a 90-degree change of direction, and rolling from bank to bank with nose held on a reference point on the horizon. Executed above 500 feet.

3. LEVEL TURNS. Precision turns with varying degrees of bank and change of direction. Careful attention to coordinated entry and recovery, and constant altitude and bank. Executed above 1,500 feet.

4. S-TURNS. Executed across a road or other reference lines. Emphasis on constant ground pattern and proper correction for drift. Executed at 500 feet.

5. RECTANGULAR PATTERN. Executed at 500 feet above a pattern on the ground. Emphasis on true rectangular pattern and proper correction for drift.

6. EIGHTS AROUND PYLONS. Executed at 500 feet with emphasis on constant altitude, ground pattern, and corrections for drift.

7. CLIMBING AND DIVING TURNS. 720-degree power-turns and maximum performance climbs completed above 1,500 feet.

8. SLIPS. Not practiced in airplanes equipped with flaps (L-5).

9. TWO-TURN POWER-OFF SPINS. Completed above 1,500 feet. Executed to the right and left, with emphasis on stopping on a selected point and recovering without gaining excessive speed. Spins are not executed in the L-5.

Section II. SPECIAL FLIGHT MANEUVERS

10. TAKE-OFFS AND LANDINGS TO PANELS. Panels mark the assumed limits of the tactical field. Power stall approaches and efficiency take-offs are made so as to attain proficiency in using minimum landing and take-off space.

11. TAKE-OFFS AND LANDINGS OVER BARRIERS. Practiced extensively using simulated barriers to develop technique in using fields with actual barriers and in estimating take-off distance.

12. TAKE-OFFS AND LANDINGS ON ROADS. Practiced on simulated roads in the landing field, using both three-point and wheel landings.

13. CROSSWIND LANDINGS AND TAKE-OFFS. Both "crab" and "slip" methods of crosswind landing and take-off should be practiced with exercises outlined in paragraphs 10, 11, and 12 above.

14. ONE-WHEEL LANDINGS AND TAKE-OFFS. Practiced in crosswinds and around simulated curved roads.

15. CONTOUR FLYING. Executed from 10 to 20 feet above the general level of trees and obstructions. For reasons of safety, this should not be performed so low as to require zooming up over trees, wire lines, and other obstructions.

16. LANDINGS FROM CONTOUR APPROACHES. Upwind approach $\frac{1}{2}$ mile from the field, at an altitude of about 50 feet, with emphasis on proper timing in closing the throttle to effect the landing and stop the airplane between two panels.

17. EVASIVE MANEUVERS. Practiced by diving to low altitudes and contour flying back to the field, making use of broken ground patterns, tree lines, creek lines, etc.

Section III. EXTENDED FLIGHT SHEET

18. FLIGHT PLAN.

AIRPLANE	(Number)	(Type)	(Pilot's Name)	
				/CFR
	(Point of Departure)	(Altitude)	(DRT or AWYS)	
	(Destination)		(Airport)	
Transmitting Frequency		(Take-off time)	(Est time enroute)	(Hours of fuel aboard)
Receiver only		(Indicate one)		
No radio in 200-400 kc band				(Remarks)

NOTES:

- (1) Enter designation of check point.
- (2) Enter *true* course to this point in degrees.
- (3) Enter true heading to this point in degrees.*
- (4) Enter *compass* heading to this point in degrees.*
- (5) Enter distance to *this* point from *last* check point in miles.
- (6) Enter estimated ground speed based on any available data.
- (7) Enter estimated time of arrival at this check point.
- (8) Enter actual time of arrival at this check point.
- (9) Enter actual ground speed to this check point from the last one. This will normally be the basis for your estimate of ground speed to the next check point.
- (10) Enter currently revised estimation of time of arrival at destination.
- (11) Enter actual time of arrival.

*Change if necessary as the flight progresses.

APPENDIX IV

LOADING FIELD ARTILLERY LIAISON AIRPLANES FOR SHIPMENT

(Models L-2B, L-3B, L-4, L-4A, L-4B, and L-4H)

Section I. GENERAL

1. METHODS OF LOADING.

- a. Loading complete airplane in 2½-ton, 6 x 6 truck (difficult terrain).
- b. Loading complete airplane in 2½-ton, 6 x 6 truck (open terrain).
- c. Railroad boxcar loading (two airplanes per car).
- d. Railroad boxcar loading (three airplanes per car).
- e. Loading in overseas shipping crate (L-4, L-4A, L-4B, and L-4H).

2. FACTORS DETERMINING CHOICE OF METHOD.

- a. Facilities and equipment available.
- b. Time available.
- c. Distance of required movement.
- d. Nature of terrain.

3. MISCELLANEOUS.

a. Disposition of small parts.

- (1) If removed, rudder, horizontal tail surfaces, and landing gear vees should be placed in cabin, padded, and tied down.
- (2) Propeller may be stowed in cabin or other suitable place.
- (3) Bolts and nuts which are removed should be replaced in the parts removed from the airplane.

b. Tie-downs and attachments.

(1) On fuselage: Propeller shaft, engine mount, fuselage spar butt fittings, fuselage landing gear vee fittings, tail lift handle (s), tail leaf spring.

(2) On wings: Spar butt fittings, lift strut fittings.

c. Use of jigs.

(1) Attach to any of the tie-down or attachment points mentioned above.

(2) Use separate set of bolts and nuts for attaching jigs; do not use bolts or nuts required in assembling the airplane.

(3) Belly jigs which are not attached to fuselage landing gear vee fittings must be placed at cluster welds.

Section II. LOADING COMPLETE AIRPLANE IN 2½-TON, 6 x 6 TRUCK (Difficult Terrain)

4. REQUIRED DISASSEMBLY.

a. Wings, lift struts, jury struts, propeller, landing gear, horizontal tail surfaces, and tail brace wires.

b. Rudder (optional).

5. PROCEDURE.

a. Place empennage parts in cabin.

b. Propeller is placed in cabin or secured in truck bed.

c. Fuselage placed in center of truck bed, nose to front (fig. 25).

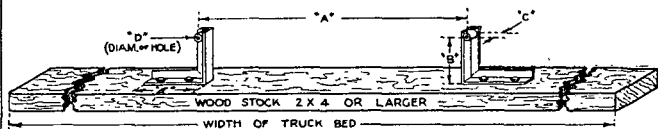
(1) Attach jig 1 (fig. 18) to front fuselage landing gear fittings (supports major part of weight).

(2) Attach jig 2 (fig. 19) under rearmost cluster weld within truck bed. (Jigs 1 and 2 support weight of fuselage and prevent side movement.)

(3) Attach jig 3 (fig. 20) to propeller shaft (prevents see-sawing and forward movement).

(4) Tie down securely.

JIG #1 FRONT BELLY JIG

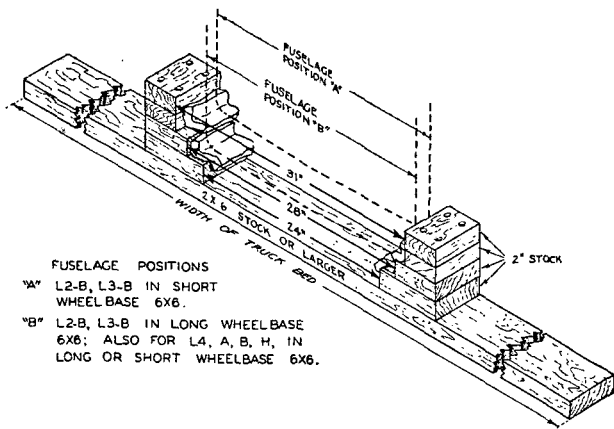


DIMENSIONS

A	L2-B	30"
	L3-B	32 3/8"
B	L4, A, B, H	26"
	L2-B, L3-B	7"
C	L2-B; L4, A, B, H	1 1/4"
	L3-B	7/8"
D	L2-B; L4	5/16"
	L3-B; L4-A, B, H	3/8"
E	6" OR MORE	

FIGURE 18. Front belly jig.

JIG #2 REAR BELLY JIG



FUSELAGE POSITIONS

A L2-B, L3-B IN SHORT
WHEELBASE 6X6.

B L2-B, L3-B IN LONG WHEELBASE
6X6; ALSO FOR L4, A, B, H, IN
LONG OR SHORT WHEELBASE 6X6.

FIGURE 19. Rear belly jig.

JIG #3 NOSE JIG

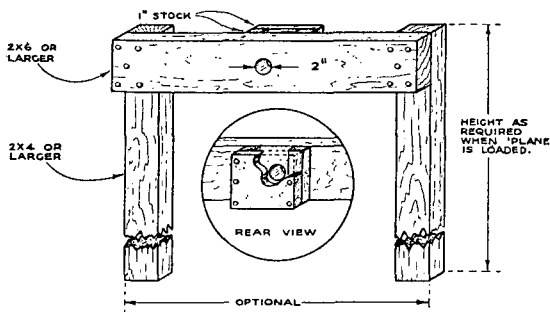


FIGURE 20. Nose jig.

d. Wings are placed on either side of fuselage, butts to front, leading edge down, bottom to the outside of truck (fig. 25). One of the following methods of support may be used:

- (1) Folding base type wing jig (jig 7; fig. 21).
- (2) Hanger type wing jigs (jigs 4, 5, and 6; figs. 22, 23, and 24).

e. Lift struts and jury struts are secured in truck bed.

JIG # 7 WING JIG FOLDING BASE TYPE

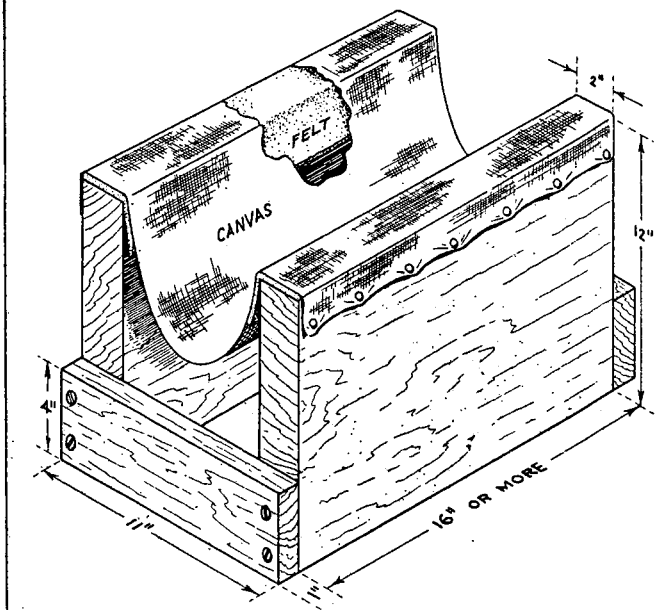
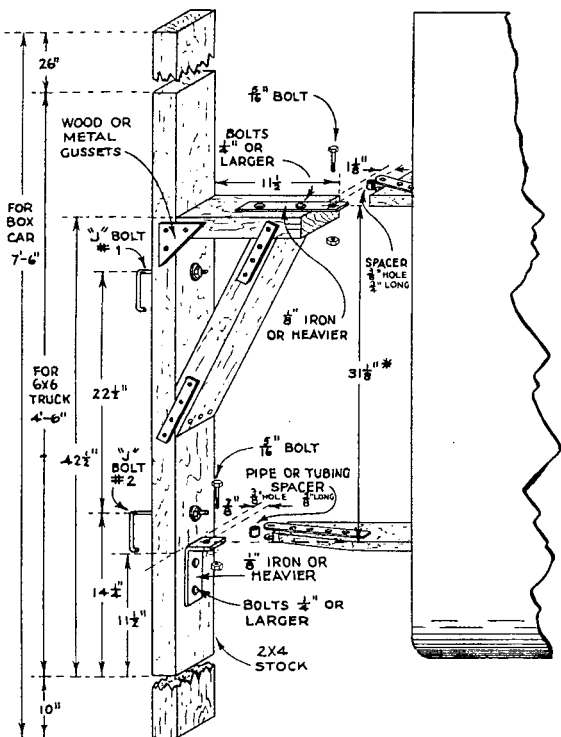


FIGURE 21. Wing jig, folding base type.

JIG #4

WING SPAR BUTT JIG



* IF OTHER THAN $\frac{5}{8}$ " IRON IS USED FOR TOP HANGER, MOVE LOWER HANGER ACCORDINGLY TO RETAIN THIS MEASUREMENT.

FIGURE 22. Wing spar butt jig.

JIG #5 WING LIFT STRUT JIG [L4, A, B, H, -L 2B]
ALSO WING SPAR BUTT JIG [L 2B-L 3B]

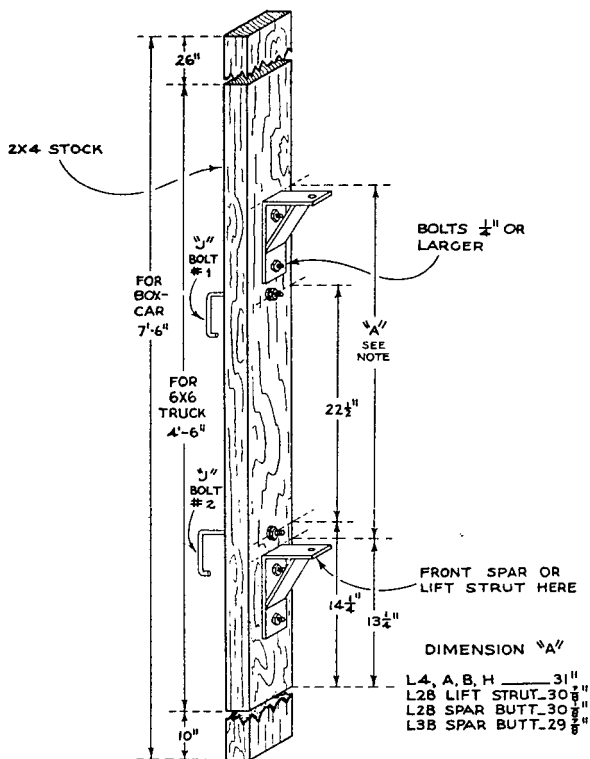


FIGURE 23. Wing lift strut jig and wing spar butt jig.

JIG #6 SPECIAL JIG FOR L3B REAR
LIFT STRUT FITTINGS

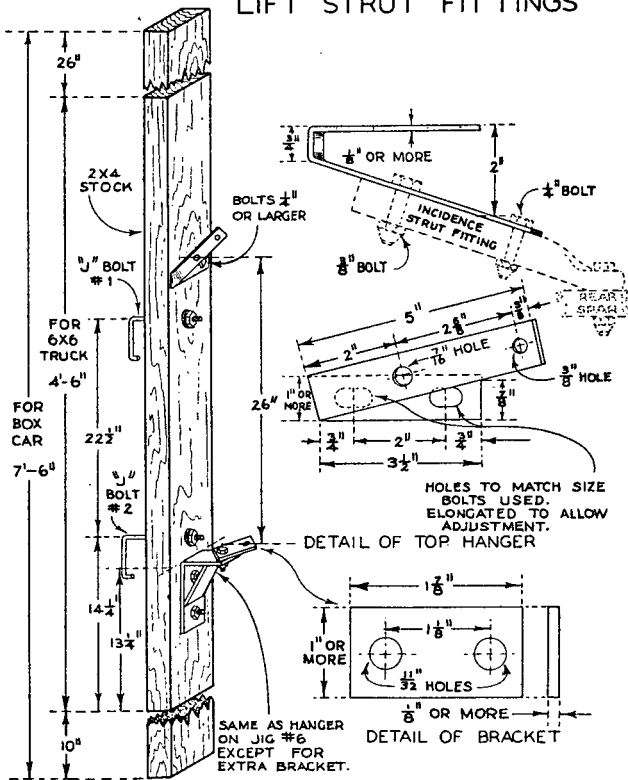


FIGURE 24. Special jig for L-3B rear strut fittings.

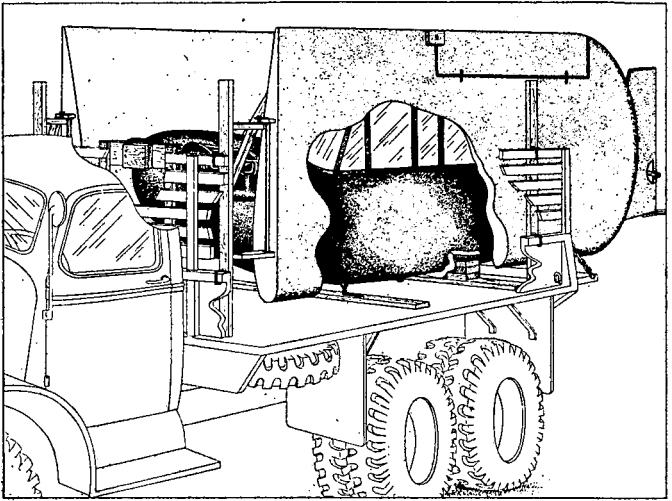


FIGURE 25. Airplane loaded on 2½-ton truck (long wheelbase).

Section III. LOADING COMPLETE AIRPLANE IN 2½-TON, 6 x 6 TRUCK (Open Terrain)

6. REQUIRED DISASSEMBLY.

- a. Wings, lift struts, and jury struts.
- b. Propeller (optional, but advisable).

7. PROCEDURE (fig. 26).

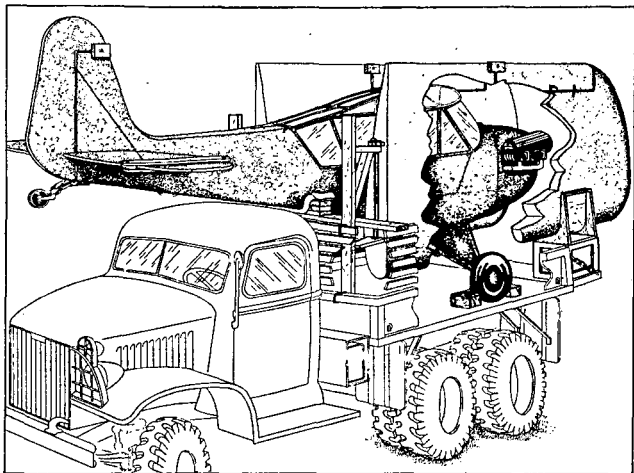


FIGURE 26. Airplane loaded on 2½-ton truck (short wheelbase).

a. Fuselage is placed nose to rear with wheels at rear of truck bed, tail over cab of truck.

(1) Chock wheels.

(2) Jig 2 (fig. 19) is placed under belly (at a cluster weld) on cab or front rack of truck.

(3) Tie down securely.

b. Mount and tie down wings as specified in paragraph 5d, except: Raise wings high enough to clear wheels by means of longer hanger type jigs or raised base type jigs.

c. Lift struts and jury struts secured in truck bed.

Section IV. RAILROAD BOXCAR LOADING (Two Airplanes per Car)

8. REQUIRED DISASSEMBLY.

- a. Wings, lift struts, jury struts, and horizontal tail surfaces.
- b. Tail wheel assembly, except leaf springs.
- c. Rudder (optional).
- d. Propeller (optional).

9. PROCEDURE (fig. 27).

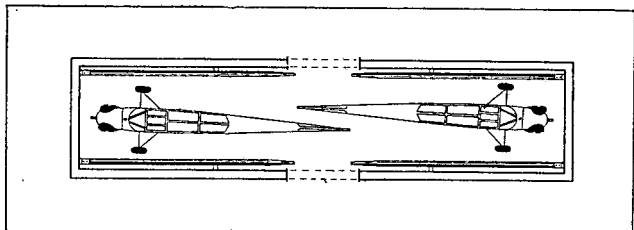


FIGURE 27. Railroad boxcar loading (two airplanes per boxcar).

a. Empennage and tail wheel parts are placed in cabin.

b. Fuselages are placed in center of car, noses toward opposite ends of boxcar.

(1) Chock wheels on all four sides, nail chocks to floor.

(2) Partially deflate tires, nail canvas straps to chocks and over tires. Reinflate tires.

(3) Leaf spring is lag-screwed to floor or bolted to block of wood nailed to floor.

c. Wings are mounted on side of car.

(1) Use hanger type jig as covered in paragraph 5d (1), except jigs will be nailed to walls of boxcar.

(2) Note dimensions of wood in figures 22, 23, and 24.

d. Lift struts and jury struts are secured to floor.

e. Propeller is secured to floor (or other suitable place).

Section V. RAILROAD BOXCAR LOADING (Three Airplanes per Car)

10. REQUIRED DISASSEMBLY.

- a. Wings, lift struts, jury struts, horizontal tail surfaces, and propeller.
- b. Tail wheel assembly, except leaf spring.
- c. Landing gear.
- d. Rudder (optional).

11. PROCEDURE (fig. 28).

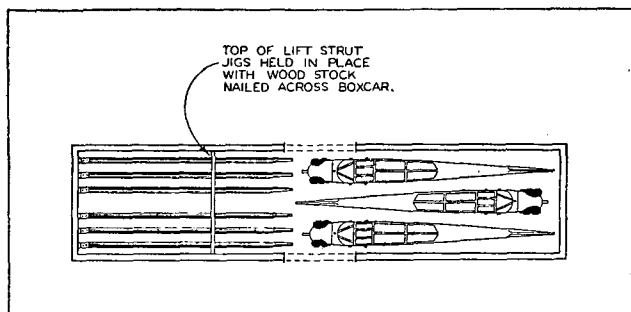


FIGURE 28. Railroad boxcar loading (three airplanes per boxcar).

- a. Place empennage, landing gear, and tail wheel parts in cabin.
- b. Fuselages are placed side by side in one end of car, with noses and tails alternated.
 - (1) Attach jig 1 (fig. 18) to front fuselage landing gear vee fittings and nail jig to floor.
 - (2) Tail leaf spring is lag-screwed to floor or bolted to block of wood nailed to floor.
- c. Wings are mounted in opposite end of car. Use hanger type jigs as shown in figure 28.
- d. Lift struts and jury struts are secured to floor.
- e. Propellers are secured in suitable place in car.

Section VI. LOADING IN OVERSEAS SHIPPING CRATE (L-4, L-4A, L-4B, and L-4H)

12. REQUIRED DISASSEMBLY.

- a. Wings, lift struts, jury struts, horizontal tail surfaces and rudder.
- b. Landing gear and complete tail wheel assembly.
- c. Propeller.

13. PROCEDURE (fig. 29).

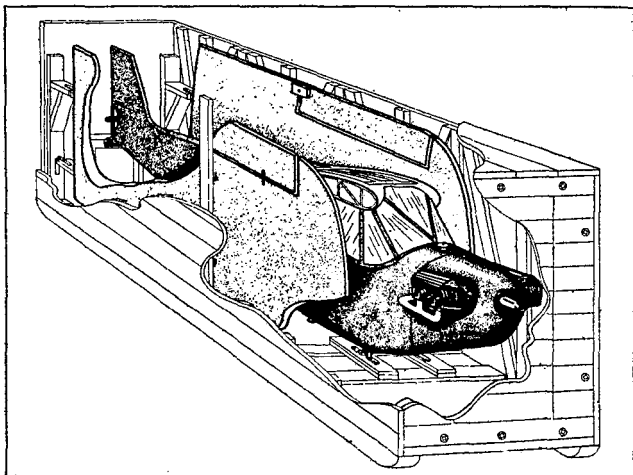


FIGURE 29. Loading in overseas shipping crate.

- a. End of crate at nose of airplane is removed by unbolting.
- b. Wings are attached to sides of crate with hanger type jigs (some crates are equipped with base type jigs).
- c. Propeller is bolted to ceiling of crate.
- d. Lift struts and jury struts are strapped to ceiling of crate.
- e. Tires, wheels, and landing gear vees are strapped to floor.
- f. Other parts are placed in cabin.

g. Fuselage is placed in center of crate.

(1) Support front by belly jig on front fuselage landing gear vee fittings.

(2) Support tail by bolting fuselage tail spring fitting to mounting plate provided in crate.

14. INFORMATION RELEVANT TO CRATE.

a. Outside dimensions: Length, 21 feet 7 inches; width, 4 feet 11 inches; height, 6 feet 9 inches.

b. Packing space: 716 cubic feet.

c. Weight complete with airplane: 4,000 to 4,500 pounds.

d. Some crates are provided with hinged doors at ends for ventilation, and to provide access for unbolting end of crate.

e. When necessary to crate aircraft, the crates must be secured through the post air supply officer.

APPENDIX V

INSTALLATION OF RADIOS IN AIRPLANES

(Models SCR-609 and SCR-509 Radios in Models L-4A, L-4B, L-4H, L-2A, L-3B, and L-3C Airplanes)

Section I. INSTALLATION IN L-4 SERIES AIRPLANES

1. GENERAL. The installation consists of two parts: The receiver and transmitter unit BC-659-B, and the battery hold-down cover.

2. RECEIVER AND TRANSMITTER UNIT BC-659-B. Following is the proper procedure for installation of the receiver and transmitter unit BC-659-B (fig. 30):

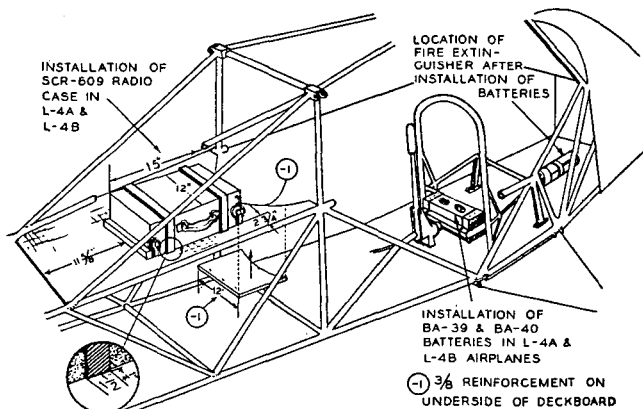


FIGURE 30. Installation of receiver-transmitter unit and batteries in L-4A, L-4B, and L-4H airplanes.

a. A 1" x 1" wood strip is set in front of the case and another behind. These 1" x 1" wood strips should have three 3/16" bolts in the front and three 3/16" bolts in the rear, spaced evenly.

b. As a precaution, a piece of wood $\frac{3}{8}$ " thick, cut to conform to the curved tube in back of the rear seat, should be placed on the underside of the decking and bolted fast with the same bolts which go through the 1" x 1" piece in front of the radio. This will prevent forward movement of the radio.

c. The case is set on the plywood decking directly behind the rear seat, on the right side. The distance from the pyralin on the right side of the fuselage to the right corner of the case is $2\frac{3}{4}$ ". The major axis of the case is parallel to the longitudinal axis of the airplane. It is necessary to move the clip for the rear control stick to the left side of the deck.

d. Four holes, $\frac{1}{4}$ " x $1\frac{1}{2}$ ", are cut in the decking. The front holes should be directly behind the front battery case clamps and the rear holes directly in front of the rear battery case clamps.

e. The regulation issue 42" waist belt can be used to hold down the case. These straps must be tightly drawn around the case and decking.

3. BATTERY HOLD-DOWN COVER. Following is the proper procedure for installation of the battery hold-down cover:

a. The batteries are set on the floor boards directly behind the front seat, the BA-39 on the right of the torque tube, the BA-40 on the left of the torque tube. The battery cover is placed over the batteries and secured by an issue web belt which passes through two metal loops on the cover and around the rear legs of the front seat. The battery cover should be made as shown in figure 31.

b. The fire extinguisher and bracket are relocated on the front floor boards between the front brake pedals, the major axis of the extinguisher being parallel to the longitudinal axis of the airplane (fig. 30).

c. The method described in section II, paragraph 5 below, can also be used.

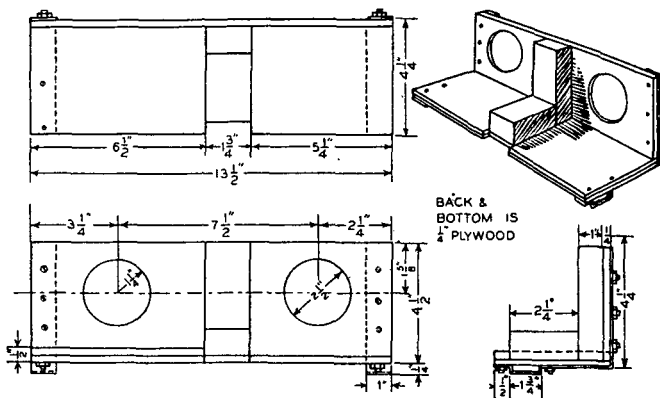


FIGURE 31. Hold-down cover for BA-39 and BA-40 battery for installation in L-4A, L-4B, and L-4H airplanes.

Section II. INSTALLATION IN L-2A AND L-2B AIRPLANES

4. RECEIVER AND TRANSMITTER UNIT BC-659-B.

Following is the procedure for installation of the receiver and transmitter unit BC-659-B (fig. 32):

a. The receiver and transmitter unit BC-659-B is centered and mounted on the floor boards behind the rear seat. Four 1" x 1" wood strips are used to eliminate any movement of the transmitter and receiver case. The wood strip at the front of the case is held down by three 3/16" bolts, the rear and side pieces by two 3/16" bolts, all bolts spaced evenly (fig. 32).

b. Two issue web belts are buckled together and used to secure the case. The belts run around the bottom diagonal structural member, which may be viewed through the left rear footwell, diagonally over the top of the set and around the rear transverse diagonal

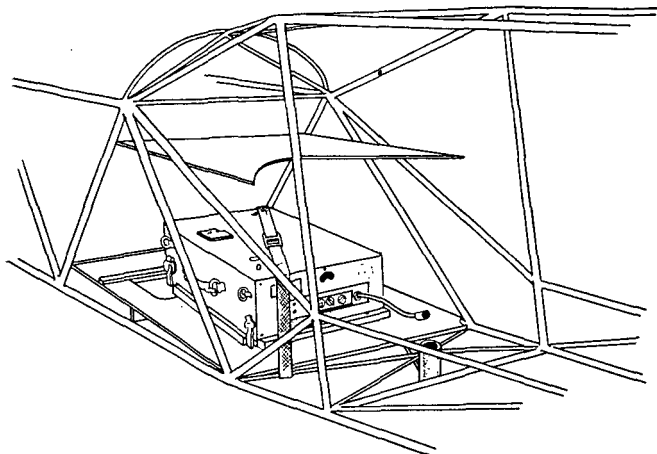


FIGURE 32. Installation of SCR-609 radio case in L-2A and L-2B airplanes.

structural member which runs from the right lower longeron up to the top of the rear seat pivot tube. These belts should be drawn as tight as possible.

5. BATTERY BOX. Following is the procedure for installation of the battery box:

a. The battery box is installed between the front brake pedals as shown in figure 33. $\frac{1}{4}$ " plywood or $\frac{3}{8}$ " crating may be used to construct the box.

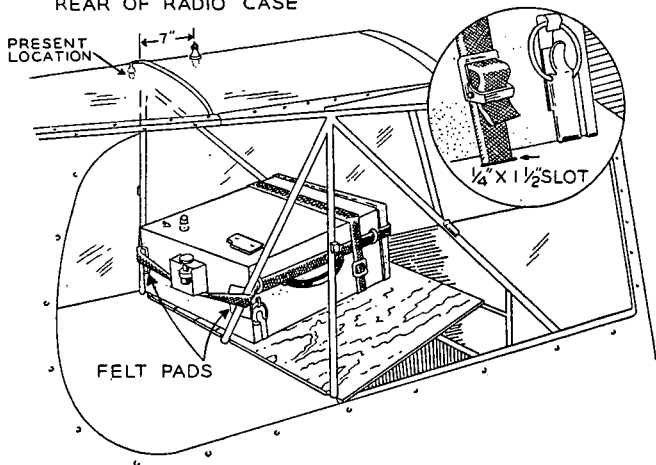
b. The box is fastened to the floor board, using No. 10 wood screws or $\frac{3}{16}$ " bolts.

Section III. INSTALLATION IN L-3B AND L-3C AIRPLANES

6. RECEIVER AND TRANSMITTER UNIT BC-659-B.

Following is the procedure for installation of the receiver and transmitter unit (fig. 33) which is mounted on the port side of the deck directly behind the rear seat:

MOVE ANTENNA INLET FROM PRESENT LOCATION TO A POINT DIRECTLY OVER REAR OF RADIO CASE



MOUNT THE BATTERY CASE ON CENTER OF FLOORBOARD BETWEEN FRONT RUDDER PEDALS AND 5" BEHIND FIREWALL

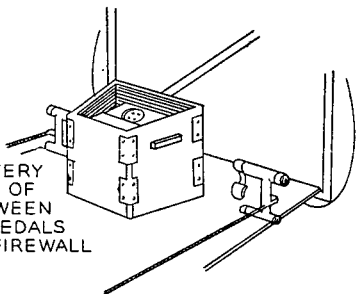


FIGURE 33. Installation of SCR-609 radio receiver-transmitter unit and batteries in L-3B and L-3C airplanes.

a. The unit is held fast by two issue web belts which run through the metal carrying loops that are attached to the case around the transverse structural tube behind the decking, then around the vertical and diagonal side-frame tubes. The belts can be buckled at the front of the case.

b. Another issue web belt is used to hold the case down. This belt runs through a $1\frac{1}{2}$ " x $\frac{1}{4}$ " hole cut in the decking, and completely around the case.

c. There should be some type of padding placed between the radio case and structural tubes (felt, cloth, etc.).

7. BATTERY BOX. The battery box is installed between the front brake pedals as shown in figure 33. $\frac{1}{4}$ " plywood or $\frac{3}{8}$ " crating may be used to construct the box.

Section IV. INSTALLATION OF ANTENNA

8. The antenna is installed between the insulator on the vertical fin fitting and the insulator on the antenna mast (fig. 34). The lead-in is connected to the forward end of the antenna. This connection will be directly behind the front insulator and will form an L-type antenna. For the SCR-609 the antenna length must be $121\frac{1}{2}$ feet, measured to include the antenna plus the lead-in from the antenna connection to the set binding post. With the installation of the SCR-509, which is operated on lower frequencies, the antenna should be the same length as the telescopic antenna issued for operation on the ground, i. e., 8 feet 2 inches.

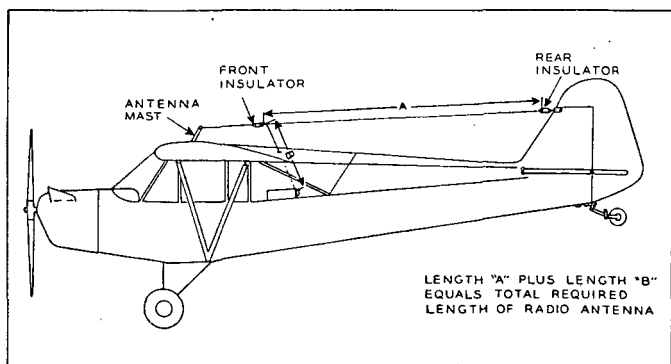


FIGURE 34. Installation of L-type antenna.

NOTE: The lead-in insulator on the L-3B and L-3C, which goes through the top deck pyralin, will have to be moved from its original position to a point directly above the rear of the decking (fig. 34).

9. The issue telescopic antenna can be mounted directly to the radio as in figure 35. This will minimize directional characteristics found in the L-type antenna.

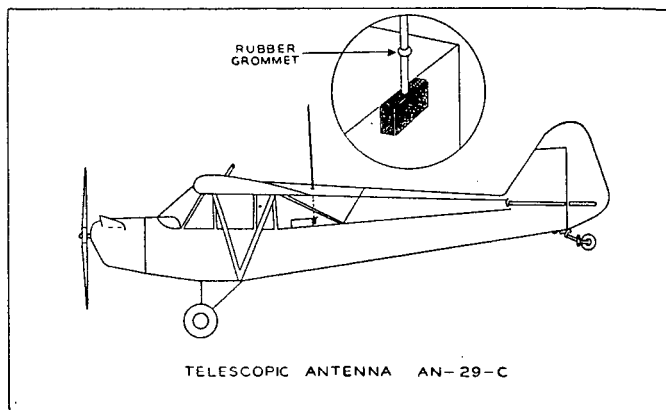


FIGURE 35. Installation of telescopic antenna.

APPENDIX VI

PUFF TARGET RANGE

1. MISSIONS. Missions are flown in a manner simulating combat conditions. The flight path of the airplane is about 4,000 to 6,000 yards from the target area.

2. TARGET AREA. The target area is approximately 900 yards wide and 800 yards deep. The terrain should be rolling, if possible, but a $\frac{1}{4}$ -ton truck must be able to drive over it rapidly. A diagram of the target area is shown in figure 36. The base point is a large white panel installed at one end of the range. The target consists of a second large white panel mounted on a $2\frac{1}{2}$ -ton truck. The location of the target truck is changed for each problem.

3. GUN POSITION. The gun position is assumed, and indicated on a map or photo, a copy of which is furnished to each pilot and observer. It is located 4,000 to 6,000 yards from the target area and is changed frequently.

4. BURST. The burst is produced by exploding a home-made lime bomb. The bomb is made by placing a small amount of lime, a detonator cap, and a short length of fuze in a paper sack. The upper portion of the sack is rolled around the lower portion containing the lime. The complete bomb is about 3 inches in diameter and 8 inches long, with the fuze projecting from one end.

5. COMMUNICATION. The SCR-609 (or SCR-509) is installed in the airplane and works with another SCR-609 (or SCR-509) located near the center of the target area. The location of this ground radio set is called the control center, and simulates a fire-direction center.

6. OPERATION. Four $\frac{1}{4}$ -ton trucks, each equipped with a supply of lime bombs, are required. One of these $\frac{1}{4}$ -ton trucks is placed near each corner of the impact area. Four telephone lines must be laid, one to the location of each of the $\frac{1}{4}$ -ton trucks. The sensing from the observer is received at the ground radio set and is plotted on a control board. The "coordinates" of the position of the next burst are then telephoned to the $\frac{1}{4}$ -ton trucks; the truck nearest to the point where the "round" should hit drives to the point designated and explodes a lime bomb. The observer senses this burst and the procedure is repeated.

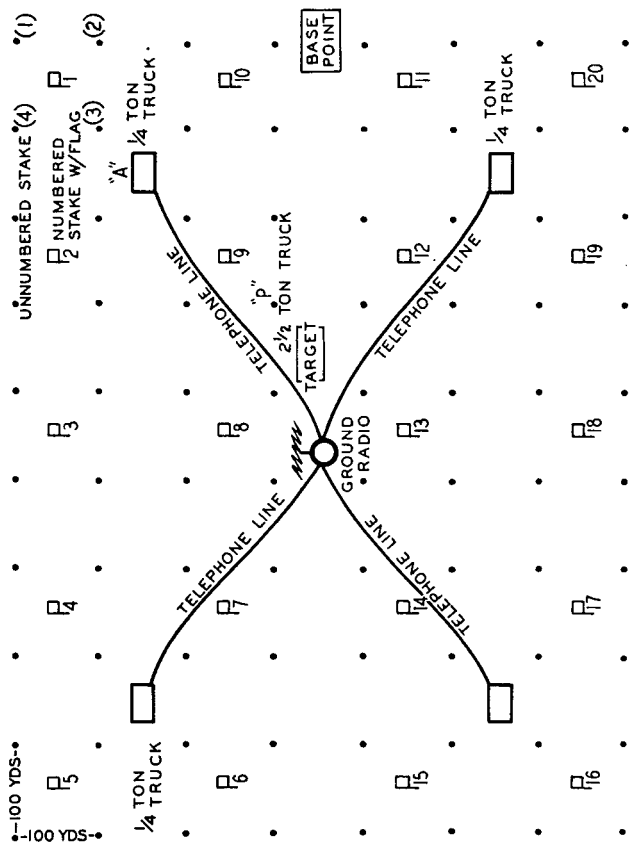


FIGURE 36. Puff target range.

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